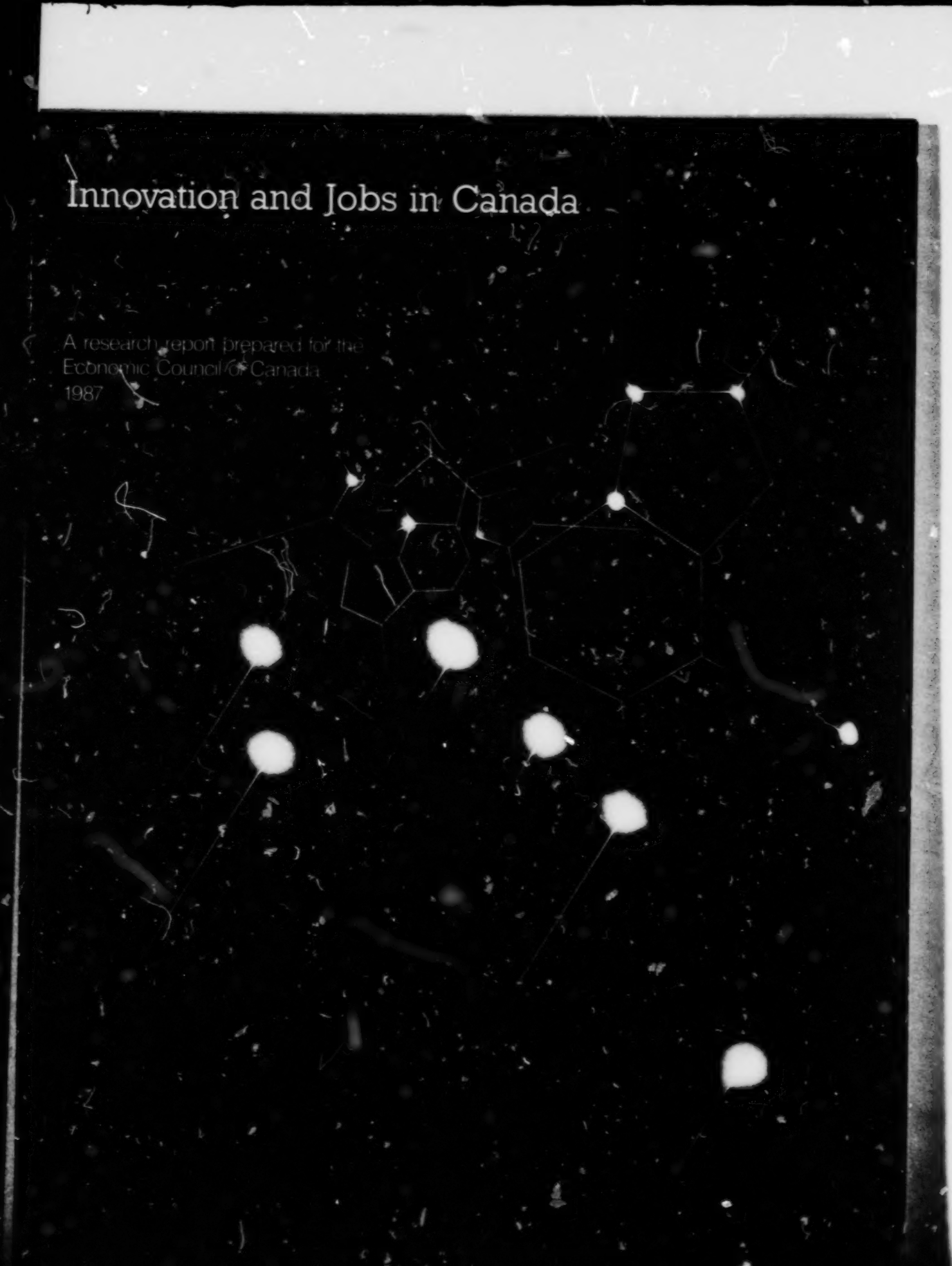
Innovation and Jobs in Canada

A research report prepared for the
Economic Council of Canada
1987



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Contents

Foreword		ix
1	**Setting the Scene**	1
	Topics and Issues	2
	The Employment Effect	2
	The Quality of the Emerging Job Structure	3
	Technological Adjustments at the Level of the Firm	3
	Connections between Technological and Organizational Change	3
	Industrial Relations Considerations	5
	Policy Issues	5
	What Is Tech Change?	6
2	**The High-Tech Sector – Employment, Efficiency, and Occupational Shifts**	9
	What is "High Technology?"	9
	Employment and Output Performance of High-Tech Industries	10
	Recent Developments, 1981-85	12
	Cost Efficiency	12
	The Evolution of Unit Production Costs	13
	Cost Effectiveness	14
	The Occupational Structure of Employment	15
	Occupational Shifts	15
	Relative Wages, Technology, and Occupational Employment	16
	Recent Developments, 1981-85	19
	Conclusion	19
3	**Sources of Canadian Employment Change**	21
	Sources of Employment Change, by Industry	21
	Sources of Employment Change, by Occupation	27
	Conclusion	34
4	**Looking Ahead**	39
	The COPS/CANDIDE Link	39
	Computer-Based Technologies to 1990	40
	MESIM	43
	Three MESIM Scenarios: Employment Impacts, by Industry	43
	Three MESIM Scenarios: Employment Impacts, by Occupation	46
	Other Uses of MESIM: The Importance of Education	54
	Conclusion	55

5	**In Search of the Declining Middle**	**57**
	The Debate	57
	Canadian Evidence to Date	58
	A New Approach	59
	The Measures	60
	Is There a Declining Middle?	60
	Conclusion	68
6	**Technological Change at the Firm Level**	**69**
	Computer-Based Innovation in the 1980s	70
	The Technologies	70
	The Innovators	73
	An International Comparison	77
	Obstacles	79
	Planning	80
	Adjusting to Technological Change	81
	Meeting New Skill Requirements	82
	Other Adjustments	85
	Conclusion	86
7	**Organizational Change**	**89**
	Workplace Innovation	90
	Forms of Workplace Innovation and Their Pros and Cons	90
	Workplace Innovations in Canada	91
	Macro-Level Developments	93
	Some International Perspectives	94
	Alternative Work-Time Arrangements	96
	Types of Arrangements	97
	Conclusion	107
8	**Technological Change and Industrial Relations**	**109**
	What are the Issues?	109
	Collective Agreement Analysis	113
	Technological Change Legislation	113
	Technological Change Provisions	114
	Enforcement of Technological-Change Provisions	120
	Federal and Provincial Experience: An Overview	120
	Issues Involved in Interpretation	120
	The British Columbia Alternative	123
	International Experiences	124
	Conclusion	127
9	**Women and The New Technologies**	**129**
	Structural Change in Female Employment	129
	Female Employment in High-Tech Industries	130
	Sources of Female Occupational Change	130
	Future Employment Prospects	131
	Employment Income	135
	Part-Time Work	135
	Innovation in Female Work Settings	137
	Employment and Immigration Canada – A Case Study	138
	Statistics Canada – A Case Study	139

Adjusting to Technological Change 140
Implications for Training and Education 141
Educational Background of Canadian Women 142
Conclusion 143

10 Special Groups and Technological Change 145
Special Groups – Who Are They? 145
Industry Employment Patterns of Special Groups 146
Occupational Employment Patterns of Special Groups 148
Educational Attainment of Special Groups 151
Expanding Opportunities for the Disabled 153
Conclusion 155

11 A Strategy for a High-Tech World 157
Objectives and Goals 157
Rapid Technological Advance 158
Raise the Profile of Science and Technology 158
Improve Technology Information 158
Enrich the Technology Debate 159
A Flexible and Well-Trained Work Force 159
Learning to Learn 159
More Skills Investment in Industry 160
Facilitate Continuous Learning 160
Providing Funds and Leave for Training 161
Improve Forecasting 162
Efficient and Equitable Adjustment Assistance 162
Easing the Transition 162
The Industrial Adjustment Service 162
Part-Time Workers 163
The Disabled 163
Innovative Management 163
Innovate on Two Fronts 164
Closer Business-Education Ties 164
Cooperative Education and Exchanges 164
Strategic Partnering 164
Elements of Success 165
Mutually Reliant Labour-Management Relations 166
Improve Collective Bargaining 166
Establish Joint Committees 167
In Conclusion. . . 167

Appendix A 169

Notes 173

List of Tables, Charts, and Figures 185

Project Staff 191

Foreword

Technological change is a crucial means to economic advancement. It is the key to improvements in productivity, global competitiveness and, ultimately, employment. Rapid adoption of new technologies is therefore vitally important to future prosperity. The Council first drew attention to Canada's poor record of technological advance in *The Bottom Line*, published in 1983. Since then the pace of technological change has accelerated and many Canadians have embraced the new technologies, some happily, some involuntarily. Yet, Canada still lags behind its trading partners, and now, with unemployment at frustratingly high rates, there is genuine concern about how the new technologies will affect people and jobs. (Employment and unemployment have been of vital interest to the Council throughout its history.)

This study marks a convergence of two important areas of economic research. Technological change has thrown traditional labour market adjustment problems into sharper focus. Where will jobs be created, where will they be lost? How do individuals prepare for them? How must organizations adjust? Do social institutions need to change? This study of the labour market impacts of technological change is unparalleled in its scope and depth of coverage. It involved not only imaginative use of existing national data sets (including projections to 1995) but also a special survey of a thousand Canadian establishments and detailed study of a handful of innovating organizations. It is designed to contribute to the important policy debate as to how adjustment to rapid technological change can be achieved both equitably and efficiently.

The Economic Council has three related objectives in any research project: to provide relevant policy advice to decision makers, to enhance public understanding of key economic issues, and to advance the boundaries of knowledge on those issues. The policy-advice and public-education goals are best met through shorter reports written for a lay audience, while the advancement of knowledge requires more in-depth analysis and explanation to meet the needs of expert analysts. Accordingly, the Council has prepared two volumes to summarize the results of this research report.

This longer report is aimed at experts in the field who wish to read an extensive, integrated discussion of the research results. It is composed of ten chapters dealing with discrete subjects. Chapter 11, A Strategy for a High-Tech World, is reprinted from the shorter Statement by Council members which is the second volume. The Statement highlights policy issues, and sets out, in its last section, a strategic policy framework. That framework is reproduced here in the final chapter.

An Advisory Committee consisting of four Council members and three outside experts representing business and labour interests, reviewed all phases of the research program. Chaired by Kalmen Kaplansky the Committee was a useful sounding board that provided the research team with helpful advice. On behalf of the Council I would like to thank all members of the Advisory Committee for their valuable and much appreciated contribution.

A special note of thanks is due to Diane Bellemare whose term on Council expired in March, before the sign-off date for the report. Her rich experience in labour market issues provided valuable input to the Council's deliberations.

Judith Maxwell
Chairman

Innovation and Jobs in Canada

READER'S NOTE

The reader should note that various conventional symbols similar to those used by Statistics Canada have been used in the tables:

-- amount too small to be expressed
- nil or zero
. . figure not available
. . . figures not appropriate or not applicable
e estimated figures
x data confidential, to meet the secrecy requirements of the *Statistics Act*.

Details may not add up to totals because of rounding.

1 Setting the Scene

Technological change affects us all. It's not new, of course: from the Industrial Revolution to the Information Revolution new products and processes have brought momentous changes to the meaning of work for millions of people. Combined with rising incomes, changing tastes, and shifts in trade and demography, new technologies have helped to create improvements in work and well-being. But currently there is considerable concern about the labour-market effects of technological change, for several reasons.

The first has to do with the general economic climate in Canada. Despite impressive rates of economic growth since the recession of 1981-82, the unemployment rate remains high. Growing pressures from international competition are forcing Canadian firms to seek out ways to reduce costs and develop new or better products. They find that they must adopt new technologies in order to maintain productivity growth and to remain internationally competitive, even though there are often misgivings about the possible employment effects. Second, the current wave of innovations is not only rapid; it is also widespread: few people's lives, at home or at work, are unaffected. Third, the new technologies are not uniform in their impact. Some industries, regions, and occupations will do better than others: there are both winners and losers. Fourth, the very unevenness of the technological impact has crucial implications for adaptation and adjustment within, and among, specific regional or sectoral markets.

While concern is widespread, agreement is not. For example, opinions differ markedly concerning the size and nature of the impact of new technologies on the labour market. Some observers maintain that we face a new surge of technological change that is historically unparalleled in the speed and breadth of its diffusion and in the severity of its effect. For them the vision of displaced workers and deskilled and dehumanized jobs is becoming a reality. We have all seen examples of the popular articles that raise the spectre of the fully automated factory, supermarket, or bank, and the consequent loss of jobs and earnings. And one of the handful of more serious attempts to quantify the impact of microelectronics on the Canadian labour market suggested "grim prospects for clerical workers in the years ahead" and "an alarmingly high rate of structural unemployment among female clerical workers" in the absence of appropriate policy initiatives.[1]

Somewhat more sanguine are those who appeal to the lessons of history, arguing that judged against such innovations as steam, electricity, and the internal-combustion engine there is nothing frighteningly revolutionary about this latest wave of change. They maintain that in the past, by and large, the additional output generated by new technologies tended to require enough labour to offset any inherent labour-saving tendencies. Dislocations have occurred, but technology-induced unemployment has not been massive, pervasive, or enduring. On this more optimistic view, the current wave of technological change is just the latest in a long series of developments that have helped to increase income and employment.

Still other analysts are essentially agnostic about the overall net employment effects of new technologies. No matter what the balance, in their view, there will inevitably be some problems of adjustment in particular industries, regions, and occupational groups. For them, the priority is to recognize and, as far as possible, anticipate the need for policies and programs to ease the pain of transition. Education, training, mobility, and social security measures are among the range of their concerns.

A final viewpoint emphasizes the notion of a "technological imperative": we have no choice but to adopt and adjust to the new technologies rapidly and smoothly. We cannot hold back the clock. Other nations are advancing and so must we, in order to maintain quality, productivity, competitiveness, and jobs. In other words, the consequences of *not* innovating may be more costly.

There are elements of truth in each of the viewpoints described above. Jobs are both created and destroyed by new technologies, and examples of each come readily to mind. But predicting the impact of any particular new product or process is, in practice, extremely difficult. So, too, is assessment of the overall net effect of new technologies on the economy as a whole. It is clear, though, that the pace of technological advance in the coming years will not be uniform across the many sectors and regions of Canada. Differences in market structures, in the design of organizations, and in institutional settings will determine the ease and rapidity with which the adjustment process takes place. In some areas there will be displacement of workers; in others there will be shortages of special skills. In short, change causes imbalances, and such imbalances may seriously impair

the economy's ability to attain satisfactory targets for growth, unemployment, and inflation.

For all these reasons the issue of the labour market consequences of technological change is clearly important. While it has received close analytical attention in the United States and Europe, there is a notable absence of systematic, comprehensive, empirical work on this subject in Canada. And not only is much of the existing research foreign; much of it is also partial, in that it deals with a particular issue such as displacement or deskilling, or with a particular technology, industry, or region. Some of it is partisan, in the sense of pursuing an ideological line. And too many studies are of the speculative, crystal-gazing variety – quite lacking in scientific rigour.

The research project reported in these pages, therefore, incorporates five explicit features. First, in the tradition of the Economic Council's work, the research is empirical and involves analysis of actual observations and statistical data sets. Second, it is comprehensive in the sense of covering all industries, regions, and occupations of the country, a number of technologies, and the interrelationships among a variety of labour-market impacts and related policy issues.

Third, the research is pitched at two levels. The more macro-level work uses elaborate modeling exercises and large data sets from Statistics Canada to analyse, among other things, the role of technology in changing employment levels and their distribution across industries and occupations. But existing data sets relating to technological change are rather limited. Thus a more micro orientation, in which we generated our own data, was also pursued. The first micro venture is based on our Working with Technology Survey (WWTS) of 1,000 Canadian establishments to elicit information on the adoption of, and adaptation to, new technologies by organizations. The second is a more in-depth study of a handful of cases that tell the story of how certain Canadian organizations, in different sectors, using different technologies, in different parts of the country, have handled the human resource consequences of tech change.

Next, the research is both retrospective and prospective. Canada's past performance is examined to see how technological change has affected the job structure and income distribution, for example. Future prospects are considered by model simulations of scenarios incorporating a variety of assumptions, such as the rate of technological diffusion and the proportion of high-tech products that we produce rather than import. In addition, the WWTS yields information on the intentions of establishments to acquire new technologies up to the end of the decade. Finally, the very nature of technological advance is such that numbers, however seductive, can never tell the whole story. Attitude and opinion, enthusiasm and apprehension, all help decide whether and how the new technologies will be introduced. The research program is therefore not only quantitative but also qualitative, drawing upon the experiences, views, and advice of a great many concerned people across the country. Consultations with trade unionists, business leaders, educators, and policy makers have been a continuing part of our efforts.

The remaining pages of this chapter deal with two principal questions. The following section sets out just what are the major topics and issues relating to the impact of new technologies on labour markets. In doing so, it refers the reader to the relevant chapters in the main body of this report. The final section then asks: What is meant by "technological change" anyway?

Topics and Issues

The Employment Effect

The employment effect of technological change is probably the single, most important concern of Canadians. In the light of the differing viewpoints described in the last section, it is hardly surprising that the Canadian evidence on this topic has so far been rather mixed. A federal task force concluded in 1982: ". . .no consensus exists on the question of the net job balance created by the development and expansion of the new technologies."[2] More optimistic was the finding of a recent Ontario task force, that

> the perception that overall unemployment problems necessarily result from technological change is wrong. While employment dislocations will occur with technological change, and are particularly noticeable in industries affected by slow economic growth, *we believe that the contribution of technological change to overall employment can be positive.*[3]

And the Council itself estimated that while technological advance in the 1970s had a labour-saving impact, this was more than offset by rising demand, so that, in fact, a substantial increase in employment took place.[4]

A problem common to these, and all, attempts to grapple with the employment effects of new technologies is what might be called the "disentanglement" problem. That is, how do we distinguish the effects of technological change from overall shifts in demand, in trading relations, in consumer preferences, in relative wages and prices, and so on? We do not presume to have final solutions to the problem, but in Chapters 2 and

3 we take the analysis a little further than heretofore. Chapter 2 first sets out the performance record of Canadian industry with respect to output, productivity, and costs, comparing the "high-tech" sector with the rest of the economy. It then looks at past shifts in the composition of employment in Canada: How has the balance of employment shifted, over time, across industries and occupations? Then Chapter 3 presents a detailed analysis of the factors that account for this. Do the shifts in employment stem from the relative growth, or decline, of the industries themselves, from the proportions of the different types of labour used, from their productivity, different production techniques, or shifts in demand?

Further evidence on occupational employment is contained in Chapter 4, where we try to anticipate possible future changes and the effects they may imply. With the aid of projections from the CANDIDE model and the Canadian Occupational Projection System (COPS), we estimate the demand for an extensive range of occupations and industries, highlighting those with large or rapid growth and those that are "high tech." However, this exercise is really just an extension of past developments and is not able to incorporate new technologies per se. We therefore turn to other sources for projections. We set out the results of our survey, for example, that provide clues as to the likely introduction of new computer-based technologies till the end of the decade. The latter part of Chapter 4 then presents the results of a modeling exercise to project the employment impacts of microelectronics-based technological change to the year 1995.

The Quality of the Emerging Job Structure

Clearly, the overall magnitude of the employment effect is a critical issue. But misgivings have also been expressed about the *types* of jobs being created by new technologies, about the skill content of jobs, and about the incomes they generate. The debate about the so-called "declining middle"[5] exemplifies this class of concerns. In a nutshell, the contention is that the emerging technologies tend to polarize the job structure and erode the proportion of middle-income jobs. This is a disturbing thought if it means that the middle class – traditionally a major source of economic and social stability – is being eroded. The issue is examined in some detail in Chapter 5. Is there evidence that the proportion of middle-class workers has declined in Canada? Has their share of employment income declined? What seems to be the role of technological change? What other factors affect the shape of the income distribution in Canada?

Closely related is another controversial and highly complex question concerning the skill content of jobs affected by the new technologies. Our case studies suggest rather mixed effects in Canada: we have encountered both deskilling and upgrading.[6] The results of the Working with Technology Survey, analysed in Chapter 6, show, among other things, that in 72 per cent of establishments, new technologies have led to the creation of new types of jobs or the substantial modification of existing ones. The meeting of new skill requirements is discussed – retraining, recruitment, the target occupations, and types of training programs. It is clear that technological advance is shaping a new occupational structure. Maybe nowhere is this better seen than in the emergence of new occupational titles in the *Canadian Classification and Dictionary of Occupations* (CCDO). Figure 1-1 sets out the new titles that appeared between 1980 and 1985. From nuclear technologist in 1980 to electronic games repairer in 1985, they are clearly related to the new technologies.

Technological Adjustments at the Level of the Firm

Although existing sets of economic data were helpful in providing the broad picture for our research program, it soon became apparent that a much finer level of detail was necessary to provide special insights on people, jobs, and technology. What kinds of firms are the innovators? Why do they innovate? What types of new technology have they adopted? And, in particular, what have been the implications for the work force in terms of skills, pay, and training? These are some of the interesting questions about organization-level adjustments to innovation that were addressed in our Working with Technology Survey and that are discussed in Chapter 6.

Unique in subject and scale, the survey yielded information from almost 1,000 establishments across Canada. A variety of industries, regions, and technologies are represented. For the first time, we have a body of information that systematically relates the characteristics of organizations, the technologies they introduce, and the human resource strategies they use to meet new employment requirements. Such information is vital, since it is at precisely this level of analysis that so many critical decisions are taken in the real world.

Connections between Technological and Organizational Change

The connection between technological and organizational change receives special attention in this report. The survey results and case studies confirm that changes

Figure 1-1

Selected Occupations that Have Emerged from New Technologies, Canada, 1980-85[1]

Type of technology:	New occupational title	First appeared in
Computer	Computer specialist: graphics	1982
	Computer specialist: micro/mini computers	1982
	Systems software programmer	1982
	Computer consultant, market support	1985
	Computerized-information processor	1985
	Training specialist, computers	1982
Computer-aided design (CAD)	CAD draughtsperson	1985
Microelectronics	Auto radio/accessories installer	1985
	Avionics assembler	1985
	Electronic games repairer	1985
	Precision metal fabricator	1985
	Cashier, electronic cash register	1980
Office automation	Word processor operator	1982
Laser	Laser-beam welder	1985
Satellite	Satellite antenna installer	1985
Fibre-optic	Fibre-optic cable splicer	1985
Solar	Solar heating equipment installer	1985
Aquaculture	Technician: aquaculture	1985
Nuclear	Control technician: heavy water/nuclear plant	1980
	Nuclear technologist	1980
	Nuclear-operations engineer	1980

1 As noted in the *Canadian Classification and Dictionary of Occupations* (CCDO), 1985.

SOURCE Keith Newton and Norm Leckie, "The employment effects of technological change," *New Technology, Work and Employment*, forthcoming, Autumn 1987.

in work arrangements – job design, reporting structures, decision-making processes, and the like – commonly go hand in hand with the introduction of new technological processes and have major consequences for the future of work. For example, there is evidence to suggest that to exploit the full potential of the new technologies, organizations may have to become less rigidly hierarchical and embrace policies and procedures to promote interdependence, mutual problem-solving, and participative decision-making among the principal stakeholders. In the process, the roles and functions of all members of the organization must be analysed, tasks recombined, jobs redesigned, and skills and knowledge explicitly rewarded. In the final analysis, the most innovative changes that a firm introduces may be embodied not in new machinery and equipment but in the imaginative blending of technological objectives with the human need for financial, physical, and mental fulfilment. Such suggestions are contained in a background study prepared for the Council[7] and are echoed in Chapter 7 of this report.

The examination of organizational change brings us close to another current issue – that of working hours. To what extent are the new technologies compatible with (or even responsible for) the current trends toward flexitime, part-time work, work-sharing, job-sharing, and working at home? Would a legislated reduction in standard working hours permit us, as some claim, to spread the productivity benefits of technological change across a larger employment base?

Innovative work arrangements extend even as far as remuneration. To what extent are the profit-, revenue-, and gain-sharing, and productivity-based payment schemes, like bonuses, spurred by, or merely accom-

panied by, tech change? And what do all these organizational changes, more collaborative modes of behaviour, and new systems of payment mean for the industrial relations system, conventional collective bargaining, and the objectives of the labour movement?

Industrial Relations Considerations

The consequences of technological change for the industrial relations system include a range of issues. The organized labour movement, for example, has voiced a number of concerns. Whether or not the occupational mix of employment is associated with an actual decline in union membership (because of increasingly white-collar modes of production, for example), there may well be some redistribution of membership among individual unions. Anxiety about job security is manifested in increasing pressure for adequate advance notice and consultation concerning the introduction of new technologies, retraining provisions, and income guarantees. Unions are also concerned about the reclassification of jobs after technological and organizational changes, about the health and safety features of new technologies, and about the equitable distribution of the benefits of such new technologies. It is likely that such concerns will have some effect on the content, and perhaps even the structure, of collective bargaining.

Collective bargaining over technological change provides the focus for Chapter 8. The contents of collective agreements are analysed and interpreted in some detail, and legislation to encourage the negotiation of technology-related issues is assessed as well. Finally, while there are limitations on the extent to which foreign experiences can be applied in this country, it is useful to consider arrangements elsewhere. Accordingly, the industrial relations of technological change in some other countries are also examined in Chapter 8.

Policy Issues

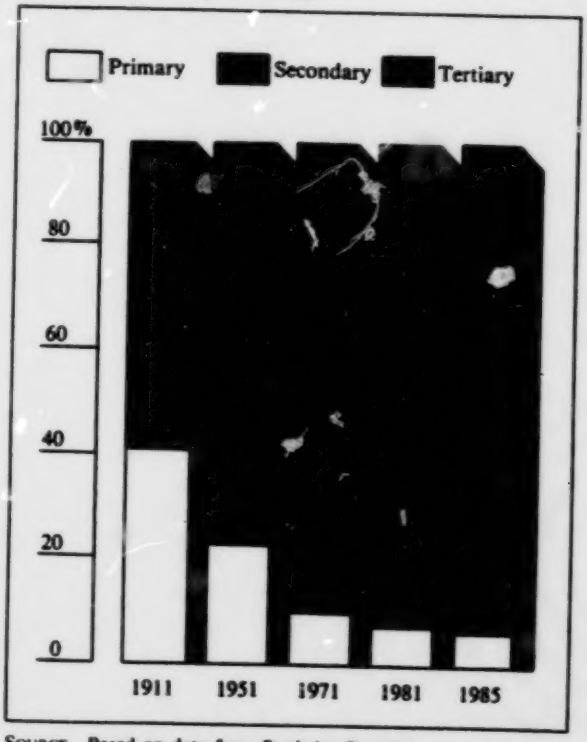
Policy issues are touched upon in all of the chapters, though some emphasize a specific policy consideration. Such is the case with Chapter 9, which deals with women and the new technologies, and Chapter 10, which deals with certain special groups such as the disabled and Native peoples, young people, and the aged. The underlying motivation for Chapter 9 is, of course, that women face special problems in the labour market and that in certain cases these could be exacerbated by technological change. How are working women distributed among the technologically affected occupations and industries, for example? Are they receiving appropriate educational preparation and vocational training? What are the prospects for female employment in the emerging job structure? Similar questions are posed in Chapter 10, where, in addition, it is shown that the new technologies hold out some promise for occupational rehabilitation of the handicapped and disabled. What is certain, however, is the need for adaptation and adjustment.

At the most general level, of course, the question is how effectively will the Canadian labour market perform the truly enormous task of adjusting to structural change. The magnitude of the challenge inherent in this continual process of adaptation is illustrated in Chart 1-1.

Changes of various kinds, including technology, have shifted the balance of economic activity in a remarkable way in the space of three-quarters of a century. From about a third of total employment in 1911 the tertiary sector has grown to over two-thirds. Meanwhile, jobs in the primary industries have shrunk dramatically.

Chart 1-1

Employment Patterns, by Industry Sector, Canada, Selected Years, 1911-85



SOURCE Based on data from Statistics Canada.

What this represents is a large, continual, often uncomfortable, but truly remarkable, process of adaptation to new products, new processes, new jobs, new skills. The process continues today. A feature of the current challenge is the rapidity of its application. Consider Figure 1-2, for example. It shows some of the occupations likely to be affected by various new technologies. It is clear that robots have already taken over many welding and spray-painting operations in the automobile industry, and CAD systems have rendered manual draughting a thing of the past in many companies. Clearly, many working lives are touched by the new technologies, in terms of job security or in terms of the nature of the work.

One issue that is central to the adoption of new technologies is education. Views are divided. Some observers argue that, with the aid of labour-market forecasting, we must identify the range of skills that are likely to be in short supply and use our educational and vocational training resources to meet those needs. Others regard forecasting as not just difficult in practice but actually harmful if done incorrectly. They warn against the dangers of being overspecific. Since the future is, at best, uncertain, they argue, specificity is folly. We must, therefore, concentrate on creating a work force that is highly mobile, flexible, adaptable, and versatile. To this end, analysts emphasize the ability to learn.

Figure 1-2

Selected Occupations Potentially Affected by Computer-Based Technologies

Technology	Occupations affected
Robotics	Welders Painters (except construction) Assemblers - autos Assemblers - electrical equipment Assemblers - electronic equipment Hoisting equipment operators Longshore workers and freight handlers Material-handling equipment operators Packagers Material handlers, labourers, etc.
ATMs; debit cards; teleshopping	Tellers and cashiers Sales workers: commodities
CAD/CAM, CNC machines	Draughting occupations Tool and die makers Machinists Machine tool operators Metalworking machine operators
Computer diagnostic equipment	Mechanics - motor vehicles Repairers - electronic equipment
Statistical inventory; storage and process control systems	Production clerks Shipping/receiving clerks Stock clerks
Automated office equipment	Typists Bookkeepers File clerks Mail clerks Telephone operators

SOURCE: Keith Newton and Norm Leckie, "The employment effects of technological change," *New Technology, Work and Employment*, forthcoming, Autumn 1987.

It is certainly clear from our analyses that the new technologies require substantial internal training for their successful implementation. This was a recurrent theme of the case studies and a major conclusion of the survey. And it appears increasingly to be the case that the traditional sequence of formal schooling, on-the-job training, and the lifetime practice of one's profession is giving way to a more cyclical pattern of *re*-education and *re*training. Technological change is rapid, so skills quickly become obsolescent, and retooling is required more often.

Governments play a crucial role. Where the market fails to yield the desired outcomes, incentives to employers may help to ensure that the appropriate quantity and quality of training is delivered. For the unemployed, information services, training, and mobility programs may ensure that job seekers are correctly equipped and located. Governments can also play a useful role in disseminating information to Canadian firms about the need to balance finely the technological and organizational advances with human resource considerations and about the ways in which they may be achieved.

Such policy considerations flow from the analysis contained in Chapters 2-10 of this *Research Report*. In our Council *Statement* - a synthesis of the present report - we distill certain policy issues into "challenges" and set out a strategic policy framework indicating how those challenges might be met. That strategic policy framework is reproduced here as the concluding chapter of this report.

We have outlined, so far, some of the topics and issues that are addressed in the following chapters of this report. We have made frequent reference to "new technologies" and "technological change." Before turning to the main body of the report, therefore, we discuss the meaning of some important terms.

What Is Tech Change?

Most of us know something about technological change. We have all experienced it personally at school, at work, and through the products we consume. Yet,

despite its power and its pervasiveness, it remains a very slippery concept that almost defies definition. There are many ways in which it can be viewed.

A popular point of view, for example, is that tech change is embodied in the latest ("leading-edge," "state-of-the-art," "high-tech") products and processes. This approach to definition is implicit in the Council's Working with Technology Survey, where we focused upon computer-based technological change and actually identified for respondents a specific list of such innovations, as shown in Figure 1-3.

It is also the approach taken in our recent nontechnical guide 8 to emerging technologies called *Workable Futures*.[8] It sets out, in an entertaining way, some useful facts and figures about:

- microelectronics,
- artificial intelligence,
- expert systems,
- computer-aided design and manufacturing,
- robots,
- computer-integrated manufacturing,
- lasers,
- telecommunications,
- office automation,
- advanced materials,
- biotechnology, and
- new organizational techniques.

For many people, "tech change" conjures up images of robots and laser beams, CAD screens and satellites, compact discs, and Concordes. Others tend to think in terms of a *process* – a process that starts with the birth of an idea and ends with its commercial application. From inventive genius through scientific experimentation, the process runs to market exploration and development, and commercial application. New inventions, continuing research and development, and an emphasis on risk-taking and entrepreneurial skills are the key ingredients of this view of technological change. And the timing of the process is critical: inventions and innovations come in clusters and show cycles or "waves" of activity. So their concurrence with the normal swings of the economy can be critical for orderly growth and development.

Some analysts, in searching for a way to account for the influence of technological change on the economy have found it convenient to think of it as "what goes on in the high-tech industries." They have then gone on to define high-tech industries according to rather arbitrary rules of thumb. In the United States, for example, several studies have labeled an industry "high tech" if it devotes more than a certain percentage of sales to R&D or if more than a certain percentage of the work

Figure 1-3

Computer Technologies in Canada in the 1980s

Process automation

Automated material-handling systems
Computer numerical control (CNC)
Computer-aided manufacturing (CAM)
Computer-aided design (CAD)
Automated inspection and quality control

Office automation

Word processing
Personal computers/workstations
Office networks
Office applications

Other automation

Transportation, communications, and other utilities – specific applications
Health services – specific applications
Point-of-sale (POS) terminals
Other applications

SOURCE Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

force is in scientific and technical occupations. At the Economic Council we have used an approach that we consider more intuitively appealing, based upon the nature of the production process itself. The criterion used in several chapters of this report, and described in greater detail in Chapter 2, classifies high-tech industries on the basis of the "high-techness" of the inputs they use.

Generally speaking, economists have had a rather tough time defining and measuring technological change. In studies of the sources of economic growth, for example, technological change has sometimes been defined as a rather mysterious residual – what's left over after other factors, such as growth in the quantity and quality of labour and capital, have been accounted for. Alternatively, economists have thought of technological change in terms of the changing mix of inputs in the production process. The use of more sophisticated machinery may save on material and energy inputs, for example. Or a better-trained work force may increase output and reduce maintenance costs. But what seems an intuitively reasonable approach has rarely gone far enough: economists have taken account of capital, labour, materials, and energy but have typically failed to capture innovations in the structure of organizations, methods of decision-making, and the design of jobs.

Such factors, however, are of critical importance. If they are neglected, even the most sophisticated new machinery and equipment may prove ineffective.

Accordingly, therefore, our approach to tech change has to be broad and eclectic. Not only must it recognize both product and process innovation; it must, in addition, acknowledge that "soft" technologies like just-in-time inventory management and statistical process control may be as far-reaching in their impact as some of the more glamorous gadgetry. Of particular importance is the whole range of innovative human resource practices that run the gamut from quality circles and venture teams through employee-involvement programs to innovations in compensation, such as gain-sharing. As outlined above, the interrelationship between technological change and organizational change receives special attention in this report.

2 The High-Tech Sector – Employment, Efficiency, and Occupational Shifts

The employment effect of technological change is a complex and controversial issue. If it is true that in the past, technological change did not cause significant and persistently high levels of unemployment but, in fact, was instrumental in fostering income and job growth, then may the same be expected for the future? But what exactly is high technology? Without a workable definition, the real impact of high technology on employment cannot be determined. Also necessary to an evaluation of the impact of technological change is a careful analysis of the historical records of high-tech users and non-users, for it is only with a good understanding of the underlying forces behind historical change that we can develop effective guidelines to plan for future changes.

The impact of technological change can be looked at from two perspectives. The first relates to the efficiency of high-tech users. The ultimate goal for the utilization of product and process innovations is to produce the best possible goods and services for both domestic and foreign consumers. Canada is a very open economy in which exports and imports are large relative to domestic production and consumption. In such a context, strong performance in terms of cost efficiency is vital to economic growth and social well-being.

The second perspective relates to individual workers who are, of course, also affected by technological change. Some of the effects occur directly as individuals encounter new technologies in the workplace, as we shall see later in this report. Other effects occur indirectly, arising out of differences in economic performance across industries, and across users and non-users of high technology. These translate into changes in the demand for various occupational skills and so into shifts in the occupational structure of employment.

In this chapter, we attempt to shed some light on those issues. First of all, our definition of high technology is presented. This is followed by an evaluation of the recent employment and output performance of the high-tech industries, as well as an evaluation of their cost efficiency. How the occupational structure of employment has been affected is then discussed, and finally some concluding comments are made.

What Is "High Technology?"

In today's world, the term "high tech" is encountered on a daily basis – in the press, on television and radio, and in casual conversation. It commonly evokes images of robots scurrying through factories; satellite dishes; compact-disc players; and orbiting space stations. While much of high tech is taken for granted, some of it arouses strong feelings, pro and con. On the one hand, some people see it as a panacea for many of the world's problems. Others, however, see high tech as a dangerous tool that threatens to widen the gulf between the haves and the have-nots.

Two definitions are commonly used to identify high-tech industries. The first is based on the ratio of spending on research and development to total sales; the second is based on the ratio of employment of scientists and engineers to total employment.[1] The major drawback of these two definitions is that they are partial in that they focus on the producers of high-tech goods and services. The impacts of technological change, however, are not confined to just the producers of high tech but involve, more broadly, all *users* of high tech. Not all high-tech users perform R&D; nor do they necessarily employ scientists and engineers. Rather than develop new technologies themselves, many users purchase high-tech inputs from outside sources.

The definition of high tech that we have developed focuses upon this broader population of the users of advanced technologies in the form of high-tech inputs to the production of goods and services. The Canadian input/output tables provide a listing of about 600 commodities, which defines the universe of all non-labour inputs used by Canadian industries. Based on a series of judgments as to the level of technology embodied in each commodity, a list of "high-tech" inputs was identified. Examples include electronic tubes and semiconductors; aircraft engines; plastic resins, film, and sheet; inorganic chemicals; measurement and control instruments; telephone and telegraph; and services to business management. For each industry, the total dollar value of all inputs that fall in the high-tech category was calculated and taken as a ratio of the value of all non-labour inputs. The industries were then ranked from highest to lowest, based on the value of their high-tech

ratios, and divided into three equal-sized groups, the top one-third being defined as high-tech; the middle one-third, as mid-tech; and the lowest one-third, as low-tech.

Like any other attempt to define so elusive and rapidly changing a concept as high tech, this definition is open to criticism and refinement. Nevertheless, while it may have some shortcomings, we believe it to be more appropriate for our purposes than other definitions currently available. The attractiveness of this measure is that it captures the users of high technology, not just the producers; it does so at a fairly fine level of industry detail; and it yields detailed time-series data.[2]

When we compared our listing of high-tech commodities to lists produced according to other definitions, we found a high degree of correspondence. Two of those other listings originated with Statistics Canada – one from the Science and Technology Statistics Division and the other from the External Trade Division.[3] Both are based on subjective judgments by outside experts as to which commodities are high tech. The third high-tech commodity listing is based upon a U.S. Department of Commerce definition;[4] the criterion used is R&D spending by product – data which are not available in Canada. While none of these lists correspond exactly, the association is high. Part of the reason for a lack of perfect correspondence is the fact that the commodity breakdowns used are not identical – the input/output commodity listing differs somewhat from the trade commodity listing, and both of these differ somewhat from the U.S. commodity listing. Other differences arise out of the fact that the criteria used vary according to purpose, with our definition focusing on the users of high tech and the others focusing on high-technology trade. Our definition, therefore, captures a larger portion of economic activity.

We compared our own definition with the "Sci-tech" definition, which identifies high-tech industries on the basis of the proportion of employment represented by scientists and engineers and so focuses on the smaller population of producers of high tech. We found that though, as expected, the absolute size of the high-tech sector differs, trends respecting employment and output growth are comparable.[5]

Employment and Output Performance of High-Tech Industries

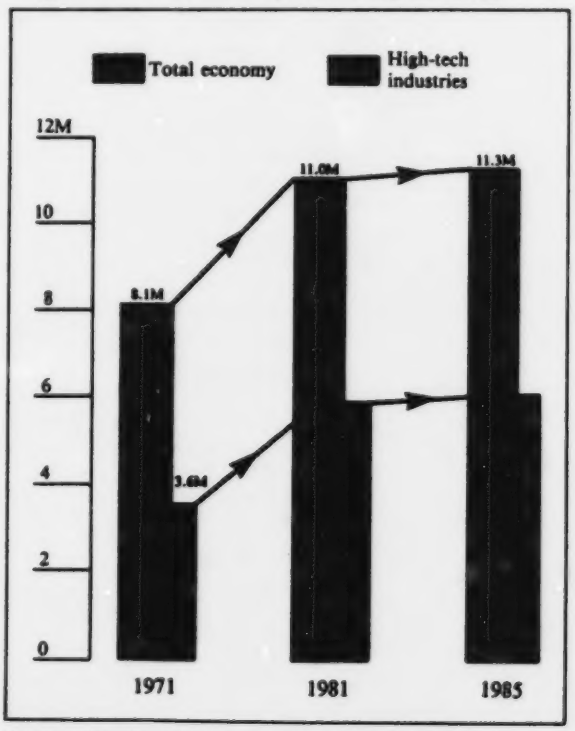
The recent employment record of the high-tech sector is shown in Chart 2-1. In the periods 1971-81 and 1981-85, employment in the high-tech sector grew considerably faster than total employment. As a result, the high-tech sector's slice of the total employment pie, which was already substantial in 1971, has been increasing.

How does the high-tech sector compare with the mid- and low-tech sectors in terms of employment, output, and productivity growth? As shown in Table 2-1, rates of employment and output growth were highest for the high-tech sector between 1971 and 1981, and lowest for the low-tech sector.[6] The pattern, however, is not as straightforward in the case of productivity growth, where, instead, the low-tech sector showed the strongest performance, averaged over the 10-year period.

Three different but complementary reasons explain this pattern of productivity growth. First, productivity growth can result from factors such as improvements in labour quality, in management, and in other inputs; from the substitution of capital for labour; and from process innovation. The fact that the high-tech sector has the edge in terms of one of those factors – namely, high-tech inputs – does not necessarily mean that it also

Chart 2-1

Employment Record of High-Tech Industries, Canada, 1971-85



SOURCE Based on data from Statistics Canada, Census of Canada, 1971 and 1981 and the Labour Force Survey.

Table 2-1

Indicators of Economic Performance, by Technological Sector, Canada, 1971-81

	Average annual growth		
	Employment	Real output	Labour productivity
	(Per cent)		
Technological sector:[1]			
High-tech	3.6	4.9	1.3
Mid-tech	3.0	3.2	0.2
Low-tech	0.6	2.8	2.2

1 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top ranking one-third were considered to be high-tech; the middle one-third, mid-tech; and the lowest one-third, low-tech. This ranking includes only the business sector and so excludes governments.

Source Based on data from Statistics Canada, and estimates by the Economic Council of Canada.

has a comparative advantage overall. Second, many high-tech companies are comparatively young. They tend to be small and are often working on the leading edge of their particular industry and technology. Economies of scale have not yet been achieved, and their labour input tends to be highly skilled and more labour-intensive than capital-intensive. As a result, their productivity performance tends not to be as strong as for large, capital-intensive firms working with established technologies. Third, in a declining industry, the surviving production units tend to be the most efficient ones. In this case, the finding that the low-tech sector performs best in terms of productivity growth is, in fact, a statistical artifact.

In terms of individual industries, there was a great deal of variation within each of the high-, mid- and low-tech sectors. Out of a total of 179 industries, 45 showed rates of employment growth between 1971 and 1981 that were well above the all-industry average.[7] Twenty-two of these were from the high-tech sector; sixteen, from the mid-tech sector; and seven, from the low-tech sector.

For nine of the high-tech industries, the reason for their good employment record was that their high rates of productivity growth were exceeded by even higher rates of output growth. The nine industries were: plastic fabricators; office and store machinery manufacturers; aircraft and parts manufacturers; manufacturers of plastics and synthetic resins; gas- and oil-facility construction; air transport; radio and television broadcasting, telephone, and telegraph and cable systems; and miscellaneous services to business and persons.

Two of these stand out as having had particularly high rates of growth; both are in the service sector. The first – miscellaneous services to business and persons – encompasses a variety of industries, including computer services; offices of engineering, business, and management consultants; accountants; and architects. Its share of the business sector's real output grew from 1.1 per cent in 1971 to 2.9 per cent in 1981. Whereas the average annual growth rate for total employment in Canada over the 10-year period was 3.1 per cent, the rate for services to business and persons was 8.1 per cent. This high rate of employment growth was the result of over 14 per cent annual growth in real output and over 6 per cent in labour productivity. The second notably high-growth industry was telephone, and telegraph and cable systems. This industry accounted for 1.4 per cent of total real output in the business sector in 1971 and for 2.7 per cent in 1981. Its average employment growth rate of over 4 per cent per year was achieved by having 11 per cent annual growth in output and 6 per cent in labour productivity.

Among the remaining seven high-tech/high-growth industries, four were from the manufacturing sector. They were relatively small industries, which together accounted for 1.1 per cent of the business sector's output in 1971 and 1.8 per cent in 1981. While the growth in relative size was considerable, it was still a small piece of the total economic pie. Employment and output growth of the manufacturing sector has been sluggish for more than two decades. In the 1970s, these four emerged as the exceptions.

Five low-tech manufacturing industries also experienced high rates of employment growth during the 1970s. Two of them obtained high employment growth through the high-output-growth/acceptable-productivity-growth route; and three, through very low or negative productivity growth. Two points should be noted. First of all, productivity decreases adversely affect workers' incomes. Second, even the apparent employment gains may be costly if achieved through productivity decline. As a rule, a decrease in labour productivity will cause production costs to increase. If the increased labour costs are large relative to total production costs, the firm or industry will, in the long run, begin to experience serious difficulties, making the affected workers and producers likely candidates for government adjustment programs in the future.

In sum, we find that the high-employment-growth industries were primarily from the manufacturing and service sectors. The number of manufacturing industries included in this group, however, was still a small fraction of all manufacturing industries. Forty-eight per cent of the high-employment-growth industries were from the service sector. Furthermore, these were char-

acterized by stable growth (a majority of them experienced consistently positive annual rates of growth in the 1971-81 period) and advanced technological status (either high-tech or mid-tech).

Among the high-employment-growth industries, the probability of being high-tech/high-output growth was very high. On the other hand, only 50 per cent of the high-tech industries also had high labour productivity growth. This, of course, does not lessen the importance of technological change for labour productivity improvement. It simply reflects the fact that many of the users of high tech are still low on the learning curve in the application of new technologies. With time, their productivity performance should improve. On the other hand, industries with both low output growth and low productivity growth are potentially more troublesome because, in the long run, they may just not be viable.

Recent Developments, 1981-85

The analysis presented so far has been based on data from the 1971-81 input/output (I/O) system of the Canadian economy. Although we have used the latest available data, it is obvious that this source of information is behind current developments by a few years. We are aware that new technologies have been introduced and implemented at an exceptional pace in recent years, making the lack of any current input/output information most unfortunate. We have attempted to partly fill this information gap with other existing data. The summary presented here is based on information from various sections of Statistics Canada. The data lack the consistency and industry detail of the I/O tables. Within their limitations, however, they may still provide us with some insights into the more recent employment performance of high-tech industries.

The first half of the 1980s was characterized by sluggish economic growth. The average annual rate of growth for the economy's real output was 2.2 per cent. Total employment increased by only 305,000 between 1981 and 1985, and many industries, regardless of their technological status, actually experienced employment decreases over the period.

Nevertheless, in the 1980s, the high-tech industries continued to be the major job creators for Canadians. High-tech industries with average annual rates of growth in employment greater than that of the national average included: communications; finance, insurance, and real estate; petroleum and natural gas; commercial services; trade; rubber and plastics; and chemical and chemical products. The only non-high-tech industries whose average annual employment growth exceeded that of the national average were: coal mines; fishing and trapping; and miscellaneous manufacturing. Among the high-tech industries in this group, 50 per cent could attribute their job creation capacity to exceptionally high rates of output growth; the remainder maintained their employment growth through a combination of better-than-average output growth and sluggish improvement in labour productivity.

Construction, metal mining, and machinery manufacturers were the only high-tech industries showing employment decreases in the first half of the 1980s. This poor employment performance was the result of the combined effect of good labour productivity growth and insignificant output growth.

In contrast, two industries – electrical products manufacturers, and the automotive industry – experienced very high rates of output growth but low rates of employment growth. In other words, strong productivity growth, partly resulting from technological change, prevented the number of jobs from growing significantly in these industries.

To a large extent, then, these more recent data suggest that the patterns found for the 1970s are continuing into the 1980s. The major job creators have been, for the most part, high-tech industries. Nevertheless, in the case of some high-tech industries, the positive impact of technological change has been most clearly reflected in increased output and productivity growth; consequently, in those industries employment growth has been negligible.

Cost Efficiency

An analysis of how well the high-tech industries are performing would be incomplete without the inclusion of a third element – cost efficiency. Cost analysis is an integral part of the current technology debate for, regardless of whether new technology is used in either product or process innovation, the bottom line for business remains the same – to produce the best possible goods and services at competitive prices for both domestic and foreign markets. Cost efficiency and successful innovation go hand in hand.

Economic theory predicts that, all other things being held constant, technological change will lower production costs. In the real world, however, all other things are in a constant state of flux. Our task here is to separate out the effects of all of the factors acting on production costs and so to determine the influence of technological change by itself. To this end, we have adopted two complementary approaches.

The first approach uses input/output data for the 1971-81 period to analyse unit production costs – that is, the costs incurred in the production of a single unit of output. Rates of growth in unit production costs are traced to their origins, of which there are two types. The first type arises from increases in the *prices* of inputs – capital, labour, energy, and materials – and the second, from changes in the *amount* of each input required to produce one unit of output. The theme of technological change comes into play in two ways. First, new technologies play a role by decreasing the costs of inputs; second, technological change can affect the productivity of any of the inputs by changing the amount of input required per unit of output. The success of high-tech industries in lowering production costs may, therefore, be traced to their advantages in having lower relative input price increases or in having superior productivity growth.

The second approach consists of a comparison of any given industry's production costs, output level, and input prices with those of a reference industry, which in this case is simply the national average. The results of this analysis enable us to answer the following question: After accounting for differences in output levels and input prices, how much lower (or higher) are production costs in high-tech industries?

The advantage of the first approach, based on an analysis of changes in unit production costs, is that it enables us to see the underlying sources of changes in production costs, both across industries and through time within an industry. Because of simultaneous movements in input prices and in input productivity throughout the economy as a whole, however, it is difficult to compare the cost efficiencies of different industries. The advantage of the second approach, therefore, is that it removes the effects of changing input prices.[8]

The Evolution of Unit Production Costs

The average annual growth rate in the consumer price index throughout the 1970s was comparatively high by historical standards. The general inflationary climate at that time was reflected in increasing prices for capital, labour, energy, and materials – and thus in increased production costs, which were passed on to the final consumer in the form of higher prices.

The average annual growth rates in unit production costs for a selection of high-tech and non-high-tech industries are shown in Appendix Table A-1 and the major sources of these increased costs are identified.[9] Between 1971 and 1981, the average annual growth rate in unit production costs for the high-tech sector was 9.23 per cent; for the mid-tech sector, 10.27 per cent; and for the low-tech sector, 10.03 per cent. Thus the performance of the high-tech sector was slightly better than that of the other sectors.

Six out of a total of 14 high-tech industries in Appendix Table A-1 had labour-cost increases as the major contributing factor underlying unit-production-cost growth.[10] Only in the case of the communications industry were the beneficial effects of good labour-productivity growth strong enough to offset substantially the influence of high wage increases. When the effects of productivity improvements in all inputs – capital, labour, energy, and materials – are taken into consideration, commercial services and communications benefited most. In the construction industry, productivity growth in labour and material inputs helped dampen the overall growth in costs. Only in trade and in finance, insurance, and real estate was productivity growth negligible for all inputs.

Increases in capital costs contributed to growth in production costs in the petroleum and natural gas and the metal mining industries. In the case of the former, these cost increases reflected the increased demand for petroleum and hence the elevated level of activity in that industry after the petroleum crisis of the early 1970s. For the remaining seven high-tech industries, increased material costs were the major contributors to growth in unit production costs.

For most of the industries classified as mid- or low-tech, rising material costs also accounted for a large part of the increases in unit production costs in the 1970s. In addition, for all of the mid-tech industries, increased labour costs were significant as well.

Also noteworthy is the fact that 11 out of a total of 13 low-tech industries listed in Appendix Table A-1 are manufacturing industries. If an increase in the spread of process technology is the next major phase of technological change, as is suggested by the results of our Working with Technology Survey,[11] then the production-cost picture for manufacturing industries will likely improve in the future.

Growth in production costs for the high-tech industries in the 1970s can, for the most part, be attributed to increasing material and labour costs. These increasing input costs were the result of rates of price increases exceeding the rates of productivity growth. Input prices are, of course, determined in the market by the forces of supply and demand. The rapid growth in employment and output that characterized the high-tech sector in the 1970s may, therefore, provide at least a partial explanation for the pattern of growth in input prices for that sector. Rapid rates of industry growth would place persistent pressure on the supply of material and

labour inputs; as a result, prices for those inputs would rise rapidly. At the same time, this was a generally inflationary period, and increased labour and material costs also played a large role in the observed increases in unit production costs in the mid- and low-tech industries. So it is apparent that very similar sources of increased costs acted to cause unit production costs to rise in all three sectors, with the high-tech sector performing slightly better than the others.

Cost Effectiveness

Analysis of changes in unit production costs alone is not sufficient to determine how industries compare in terms of cost effectiveness. This is due to the influence of input prices. To illustrate, an industry with comparatively high increases in input prices and exceptionally efficient utilization of inputs may still be classified as a poor performer. The effect of input prices must therefore be removed if we are to get a truer picture of the performance of high-tech industries in terms of cost efficiency.

Table 2-2

Cost-Efficiency Performance, Nonmanufacturing Industries, Canada, 1971-81

	Technological sector[1]
"High-efficiency" group:	
Finance, insurance, and real estate	High
Construction	High
Forestry	Low
"Above-average-efficiency" group:	
Petroleum and natural gas	High
Communications	High
Transportation and storage	Mid
"Average- or below-efficiency" group:	
Metal mines	High
Commercial services	High
Nonmetal mines, except coal	Mid
"Poor-efficiency" group:	
Trade	High
Coal mines	Mid
Agriculture	Mid
Utilities	Mid
Fishing and trapping	Low

1 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top ranking one-third were considered to be high-tech; the middle one-third, mid-tech; and the lowest one-third, low-tech. This ranking includes only the business sector and so excludes governments.

Source: Based on data from the Input/Output Division, Statistics Canada, and estimates by the Economic Council of Canada.

Table 2-3

Cost-Efficiency Performance, Manufacturing Industries, Canada, 1971-81

	Technological sector[1]
"High-efficiency" group:	
Rubber and plastics	High
Motor vehicle parts and accessories	High
Textiles	Mid
"Above-average-efficiency" group:	
Chemicals and chemical products	High
Transportation equipment, except motor vehicles and parts, truck/trailer bodies, and miscellaneous vehicles	High
Motor vehicles	High
Electrical products	High
Machinery	High
Miscellaneous manufacturing	Mid
Printing, publishing, and allied industries	Low
Tobacco products	Low
Metal fabricating	Low
Nonmetallic mineral products	Low
Nonferrous metals	Low
"Average- or below-efficiency" group:	
Iron and steel	Mid
Knitting mills and clothing	Low
Furniture and fixtures	Low
Food and beverages	Low
Leather	Low
"Poor-efficiency" group:	
Paper and allied industries	Mid
Wood industries	Low
Petroleum and coal products	Low

1 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top ranking one-third were considered to be high-tech; the middle one-third, mid-tech; and the lowest one-third, low-tech. This ranking includes only the business sector and so excludes governments.

Source: Based on data from the Input/Output Division, Statistics Canada, and estimates by the Economic Council of Canada.

The cost efficiencies of individual industries are calculated by estimating how much lower total production costs for each industry would be relative to the average, after accounting for differences in output levels and input prices.[12] The results are summarized in Table 2-2 for the nonmanufacturing industries, which include the resource and service sectors, and in Table 2-3 for the manufacturing sector.[13]

In terms of cost efficiency in the nonmanufacturing sector, the strongest performers were the finance, insurance, and real estate; forestry; and construction industries. As we saw in the previous section, these industries – finance, insurance, and real estate, in particular – were not notably good performers in terms of growth

in unit production costs. When the effects of increasing input prices are removed, however, we find that these industries were very efficient in the management of their inputs. In contrast, the communications industry experienced very low increases in unit production costs, largely because of the relatively low increases in input prices. Once the advantage in input prices is removed, however, we find that this industry's performance with respect to cost efficiency was only average.

Seven out of the 14 industries listed in Table 2-2 are high-tech industries. More than half of them ranked in the two high-cost-efficiency groups, while only one out of five mid-tech industries did so. Of the two low-tech industries, one ranked in the highest-efficiency group and one in the lowest. The high-efficiency, low-tech industry was forestry, which showed strong productivity growth for each of capital, labour, energy, and materials. It appears, therefore, that while having high-tech status did not guarantee superior cost-efficiency performance, industries not using high-tech inputs were, for the most part, less likely to rank high in terms of cost efficiency.

Among the manufacturing industries, seven of the 22 industries listed in Table 2-3 were classified as high tech in the 1971-81 period. All seven ranked among the two highest cost-efficiency groups. While some low-tech manufacturing industries showed above-average cost efficiency, all of those in the two lowest performance categories were either mid- or low-tech industries.

In an open economy, where domestic producers face foreign competition both at home and abroad, cost efficiency is undoubtedly an essential element for survival, and the advanced technologies can play a role in improving the cost efficiency of Canadian producers. Indeed, our analysis shows that during the 1970s, the most intensive users of high-tech inputs tended to turn in the best cost-efficiency performances. These results suggest that the adoption of advanced technologies by mid- and low-tech industries would contribute toward reductions in production costs and, consequently, toward increased competitiveness and economic growth for the Canadian economy. In the long run, such increased growth translates into more jobs for Canadians.

The Occupational Structure of Employment

Thus far in this chapter we have examined the performance of the high-tech sector relative to the rest of the economy in terms of output and employment growth, unit costs of production, and overall efficiency. In this section, our focus is on how changes in industry structure as a result of interindustry differences in economic performance translated into shifts in the demand for occupations in the 1971-81 period. Our interest in occupational shifts arises, of course, out of a broader concern with the implications of technological change for employment and job security in various occupations. Indeed, employment decline in certain occupations has often been cited as an inevitable concomitant of technological change. But technology is not the only source of change. Changes in demand, relative wages, and a host of other factors can all lead to changes in occupational employment levels.[14] In this section, we examine historical evidence on shifts in the job structure of the Canadian economy. We then show the role that technological change may have played in bringing about changes in occupational employment.

Occupational Shifts

In recent years, some occupational groups have experienced substantial increases in the demand for their skills, while others have seen their shares of total employment dwindle significantly. Between 1971 and 1981, employment of managers and administrators[15] grew by 235 per cent. For occupations related to assembling and repairing for textile, fur, and leather products, employment growth was only 28 per cent during the same period. And the situation was far worse for wood machining occupations; employment for this occupational group actually decreased by 2.8 per cent between 1971 and 1981. Whatever forces were at work, they did not affect all occupations to the same degree, nor even in the same direction.

A simple way to visualize shifts in the occupational structure of employment is to think of two main influences. The first is the relative growth or decline of particular industries: if agriculture as a proportion of all economic activity diminishes in size, one can expect the numbers of farmers and farm labourers to diminish too; and if the software industry takes off, one can expect an increase in the demand for computer programmers. This, we call the "industry effect." The second factor is changes in the labour mix *within* any particular industry: the automotive industry might use proportionately fewer production workers and more managers, for example; or health care might employ proportionately more paramedics. This, we call the "manpower-mix effect."[16]

For the total economy, the employment figures rose from 8.1 million in 1971 to 11 million in 1981, an increase of 36 per cent for the decade. Although overall job creation was satisfactory, it was not sufficient to offset even more rapid growth of the labour force. Partly as a result of this development, the average

annual unemployment rate increased from 6.2 per cent in 1971 to 7.5 per cent in 1981.

Generally speaking, the industry effect accounted for the largest portion of the change in occupational employment between 1971 and 1981. Out of a total of 82 occupations, 61 showed industry shifts as their major source of occupational employment change. As for the manpower-mix effect, in more than 50 of the occupational groups, this factor was responsible for 15 per cent or more of the employment change over time.

The very high rate of growth in the "other managers and administrators" group translated into a total of 336,000 new jobs between 1971 and 1981. Manufacturing, trade, and finance, along with community, business, and personal services, were the major employers of this group. The most important factor in determining growth in employment of managers and administrators was the change in the manpower mix within industries. It accounted for about 55 per cent of the employment increase in this group. Unlike in the case of many other occupational groups, differential growth across industries was relatively unimportant in explaining the observed changes over time. As is explained later in this section, the change in the manpower mix was heavily influenced by technological change. At this point, suffice it to say that the new production technologies of recent years have increased the demand for administrative and managerial skills.

Employment of clerical and related workers[17] increased by 737,000 between 1971 and 1981 – a growth rate of 57 per cent. Not only was the absolute number of jobs involved large, the growth rate was also well above the national average. Manufacturing industries provided only 5.5 per cent of the increase in clerical jobs in 1971-81 (Table 2-4). In contrast, trade; finance, insurance, and real estate; and community, business, and personal services accounted for 69 per cent of the total increase in clerical employment. Hence growth in the service industries was primarily responsible for the employment gains of clerical workers.

In manufacturing, all blue-collar occupations, with the exception of the wood machining and other processing group, experienced low but still positive employment growth. The sluggish growth in these occupations primarily reflected the relatively slow output growth in manufacturing over the decade; in many cases, the positive impact of output growth on occupational employment was just large enough to offset the negative impact of productivity gains arising from the use of new technologies.

Occupational groups having employment growth rates above 100 per cent between 1971 and 1981 were:

Table 2-4

Distribution of Employment Increases in Clerical and Related Occupations, by Industry, Canada, 1971-81

	Employment increases
	(Per cent)
Agriculture	0.9
Forestry	0.3
Fishing and trapping	0.1
Mining	1.6
Manufacturing	5.5
Construction	3.6
Transportation, communications, and other utilities	9.0
Finance, insurance, and real estate	15.8
Trade	24.6
Community, business, and personal services	28.7
Public administration	9.9
Other	0.1
Total	100.0

SOURCE: Based on data from Statistics Canada, and estimates by the Economic Council of Canada.

occupations in law and jurisprudence; library, museum, and archival sciences; performing and audio-visual arts; writing; sports and recreation; bookkeeping, account-recording, and related occupations; and fabricating, assembling, and repairing occupations in the wood products industries. Changes in the manpower mix were relatively more important for those occupations than for the others. The only exception was occupations in law and jurisprudence, where the industry effect was entirely responsible for employment growth.

At the same time, a number of occupations failed to grow significantly in the 1970s; others experienced actual employment declines. Examples include farmers and occupations in the physical sciences, personal services, forestry and logging, and in railways.

Relative Wages, Technology, and Occupational Employment

At any point in time, labour demand by occupation is determined by the level and composition of output, and by technology and relative wages. In order to determine what the distinct impact of technological change on occupational employment has been, it is necessary that the impacts of changes in output and relative wages be separated from the technology impact.

To this end, the following steps were taken. First, the impact of changes in relative wages was removed by

assuming that relative wages did not change between 1971 and 1981. Second, the amounts of labour required to produce the 1971 level of output were calculated. These labour-input requirements were then applied to the 1981 level and composition of output. This tells us how much of each occupational group would have been required to produce the 1981 level of output had the technology of 1971 been used. Third, this hypothetical level of employment for each occupation was compared with the (hypothetical) level in 1981 (when the relative wage change effect is removed). The difference between the two is the effect of technological change on occupational employment after accounting for differences in output levels and relative wages.[18] The results of this procedure are summarized for a selection of occupations in Chart 2-2.

It is clear that the effects of technological change on employment varied from occupation to occupation. For some occupations, the use of the 1971 technologies in 1981 would have generated employment levels that were lower than the actual 1981 levels. The total net employment effect for the economy as a whole, however, was such that potentially more than 545,000 workers could have been added to total employment in 1981 had the 1971 technologies been used in 1981.

For about 38 per cent of the occupations, the use of the 1971 technologies would not have increased employment levels; on the contrary, it would have effectively lowered the demand for workers in those occupations. In these cases, technological change to 1981 was "labour-using."[19] A clear example can be found in the occupational group that includes all managers and administrators in the economy except officials and administrators unique to government. The use of the 1971 technologies would have substantially reduced the employment of that group in 1981. For 96 per cent of the industries in question, the unit labour requirement for that occupational group (that is, the number of managers and administrators per unit of real output) was actually higher in 1981 than in 1971. To a certain extent, the opposite effect can be seen in other occupations related to management and administration.[20] It is likely that the spread of office-automation technologies made the tasks of auditing, accounting, and purchasing management characteristic of this group, less time-consuming; consequently, the amount of labour required per unit of output was lower in 1981 than in 1971.

Our estimates indicate that employment in 62 per cent of the occupational groups was unfavourably affected by technological change in the 1971-81 period. In those cases, technological change was of a "labour-saving" nature. Of course, not all of the unfavourably affected occupations experienced absolute declines in their employment levels. In fact, the majority of them experienced employment growth over the 10-year period. Our results simply show that their employment levels would have been even higher without the "labour-saving" effect.

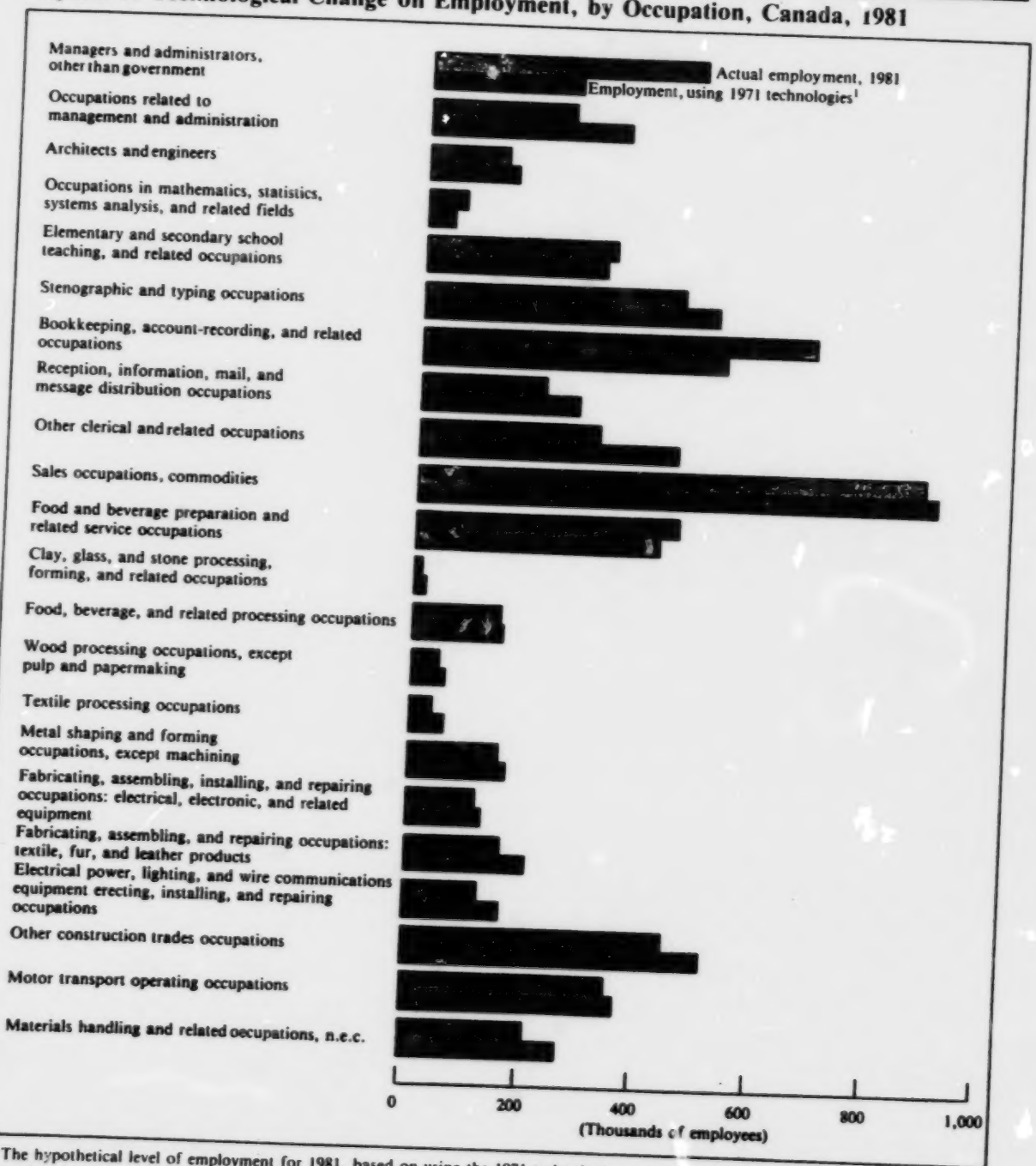
Of the total of 82 occupational groups, 21 were manufacturing occupations. One-third of the latter experienced employment growth as a result of technological change between 1971 and 1981; one-third experienced moderate employment decreases; and one-third experienced severe employment decreases. Similarly, 39 per cent of the nonmanufacturing occupations experienced increases in employment as a result of technological change over the decade; 28 per cent were moderately affected; and 33 per cent experienced large employment decreases. Most of the occupations that showed employment growth were concentrated in the service sector.

In our work on changes in the distribution of income as a result of technological change, reported on in Chapter 5 of this report, the spectrum of all occupations has been classified into high-, middle-, and low-income groups. Of the 31 occupational groups that enjoyed employment growth between 1971 and 1981 as a result of technological change, 10 were classified as high-income; 11, as middle-income; and 10, as low-income. Thus technological change was not particularly prone to producing "working poor."

Do the 27 most negatively affected occupations show common characteristics in terms of level of skills and education required? A close examination of the occupational descriptions contained in the Canadian Classification and Dictionary of Occupations yields a rough approximation of the educational attainment and skill contents associated with individual occupations. Our assessment suggests that the popular belief that labour-saving technologies tend to have the most severe impacts on least-skilled workers may be true to a certain extent. At the same time, some highly skilled occupational groups, including accountants, auditors and related officers, physical scientists, and lawyers also experienced relatively low rates of employment growth. Those professions are clearly not the unskilled workers implied by the popular belief. Other occupations that were severely affected by labour-saving technologies, however, include occupations in reception, information, mail and message distribution; other clerical and related occupations; other sales occupations; occupations in lodging and other accommodations; and some occupations in agriculture, forestry, and manufacturing, and in transportation, communications, and other utilities. Most of the jobs in question required relatively little skill and education; some required specific skills but only a small amount of formal education. Thus it was the skilled tradesman, the semiskilled, and the unskilled, rather

Chart 2-2

Impacts of Technological Change on Employment, by Occupation, Canada, 1981


Managers and administrators, other than government
Occupations related to management and administration
Architects and engineers
Occupations in mathematics, statistics, systems analysis, and related fields
Elementary and secondary school teaching, and related occupations
Stenographic and typing occupations
Bookkeeping, account-recording, and related occupations
Reception, information, mail, and message distribution occupations
Other clerical and related occupations
Sales occupations, commodities
Food and beverage preparation and related service occupations
Clay, glass, and stone processing, forming, and related occupations
Food, beverage, and related processing occupations
Wood processing occupations, except pulp and papermaking
Textile processing occupations
Metal shaping and forming occupations, except machining
Fabricating, assembling, installing, and repairing occupations: electrical, electronic, and related equipment
Fabricating, assembling, and repairing occupations: textile, fur, and leather products
Electrical power, lighting, and wire communications equipment erecting, installing, and repairing occupations
Other construction trades occupations
Motor transport operating occupations
Materials handling and related oecupations, n.e.c.
Actual employment, 1981
Employment, using 1971 technologies[1]
0
200
400
600
800
1,000
(Thousands of employees)

1 The hypothetical level of employment for 1981, based on using the 1971 technologies to produce the 1981 basket of goods and services.

SOURCE Based on data from Statistics Canada.

than the managerial and professional groups, who bore most of the burden of technological displacement. This conclusion is further reinforced by examining the rates of employment growth of these 27 occupations. Twenty-one of them grew more slowly than the total economy; indeed, six of them experienced absolute decreases in employment between 1971 and 1981. Only six occupations had rates of employment growth equal to, or greater than, the national average rate.

Generally speaking, occupations concentrated in manufacturing activities were more unfavourably affected by technological change than occupations in other sectors of the economy. About 70 per cent of the jobs in manufacturing were sensitive to labour-saving technologies. A reduction in the amount of labour required per unit of output as a result of technological change does not necessarily entail a detrimental effect on employment if output grows sufficiently to offset the gain in production efficiency. Manufacturing output growth, however, has been sluggish for a number of years. If manufacturing jobs are to grow at an acceptable rate in future, output will have to grow even more. This means that the competitiveness of Canadian manufactured goods in international and domestic markets must be greatly improved in the years ahead.

Recent Developments, 1981-85

Ideally, an analysis of the occupational employment effects of technological change would extend into more recent years than 1981, but the Statistics Canada data required to do this were simply not yet available at the time of writing. Consequently, we can only observe what the most recent employment trends have been without isolating the impact of technological change from the effects of changes in output levels and relative wages.

Of the occupational groups that were most negatively affected by technological change in the 1971-81 period, 36 per cent experienced strong rates of employment growth – more than twice the national average – between 1981-85. The remaining 64 per cent either had insignificant employment growth or experienced declines in their levels of employment, as expected. Therefore, while it is likely that those occupations which were most affected by labour-saving technologies in the 1970s will continue to face job scarcity in the future, it is also clear that economic growth and structural changes in the Canadian economy may offer selected occupations new employment opportunities as time goes on.

Strong rates of employment growth were also experienced by a number of occupations in the moderately affected group and by most of those which benefited from technological change in the 1970s. By and large, the directions of these employment changes are as might have been expected from our earlier analysis.

Conclusion

In order to study the impact of the high-tech sector on the Canadian economy, we found it necessary to develop a definition of high technology that would include not just the producers of high-tech goods but also the wider population of users of high-tech inputs for the production of goods and services. The results of our analysis show that, overall, the high-tech sector experienced higher rates of employment and output growth throughout the 1970s and into the 1980s than did the mid- and low-tech sectors. In most cases, the rate of output growth was sufficiently high to offset the negative employment impacts of productivity growth, with the result that employment in that sector grew as a proportion of total employment. Nevertheless, in the case of a few high-tech industries, notably the electrical products and automotive industries, output in the 1980s failed to grow at rates sufficient to offset the negative impacts of productivity growth, with the result that recent employment growth in those industries was negligible. Furthermore, the high-tech sector is characterized by a high degree of turbulence, arising out of the high rates of firm births and deaths, and by variability in the patterns of employment and output growth.[21]

In terms of other indicators, we have found that the high-tech sector also performed better than the mid- and low-tech sectors. While all three sectors have been affected by similar sources of increase in the costs of production – namely, rising labour and material costs, primarily – the high-tech sector turned in the best performance with respect to the efficiency with which the inputs to the production process have been combined.

What, then, do these analyses tell us about the employment prospects of the high-tech sector? First, it is clear that technological change plays an important role in increasing output levels; however, unless those higher levels of output exceed the accompanying productivity gains, employment growth will at best be negligible or at worst, be negative. Ultimately, increased productivity, particularly if combined with increased product and service quality, will translate into increased competitiveness, which in turn will enable output levels to increase as Canadian goods and services meet with growing success in domestic and international markets.

Inevitably, of course, technological change will also lead to occupational shifts, as different industries grow at different rates and as the mix of occupational inputs

changes within individual industries. Occupational shifts are not a new phenomenon; rather, they have always characterized economic growth, for industries rise and fall with changes in consumer tastes, in the balance of international trade, and in technology. In the final analysis, then, adjustments on the part of individual workers will be inevitable. It is the task, therefore, of all concerned – government, industry, and labour – to ensure that the process of adjustment occurs smoothly, quickly, and equitably. Some recommended policy directions to faciiitate this adjustment process are outlined in Chapter 11 of this report.

3 Sources of Canadian Employment Change

This chapter examines the sources of Canadian employment change for the period 1971-81. It provides a more detailed and more complete examination of the occupational employment shifts discussed in the previous chapter. We analyse 39 distinct industries and 85 occupations, covering the whole business sector of the Canadian economy. The sources of employment change by industry are shown to be related to the sources of employment change by occupation. All this permits a deeper understanding of the basic economic forces that are responsible for Canadian employment change. It will be found that for many individual industries and many individual occupations there are some unique features characterizing the sources of employment change. At the same time, however, it will be found that there are some important common elements exposed by our analysis.

This chapter also provides the background for some of the succeeding chapters. For example, the employment projections of Chapter 4 are partly based on the historical data of this chapter. Indeed, it is revealing to compare the changes in Canadian employment (by industry and by occupation) for the period 1971-81 with those projected for various scenarios to the year 1995. The historical data, in a sense, furnish a "richer" story of sources of employment change because the data reflect the full reality of actual events. Projections, on the other hand, mainly reflect the assumptions of the models on which they are based. But projections may be more useful for economic-policy purposes. The type of analysis used in this chapter is applied again in Chapters 9 and 10 of this report.

Before turning to the substance of our analysis, two further points should be clarified. The presentation in this chapter is really a simplified version of a more complex analysis that appears as a supporting technical study.[1] Some of these "complexities" are briefly mentioned in the concluding section of this chapter. The other point is that some readers may regard our historical analysis for 1971-81 as being considerably out-of-date. At the time of this writing it is not possible to update the resulting tables and analysis without using data of an inferior quality and/or making arbitrary assumptions. We believe that it is more revealing to stick to reliable data that are available for the time period 1971-81. Indeed, updating and/or extrapolation are best done within the context of projections, and that is the purpose of the next chapter (Looking Ahead).

Sources of Employment Change, by Industry

As already mentioned, we are concerned with sources of Canadian employment change, both by industry and by occupation. Since the sources of employment change by occupation stem largely from the industries where the various occupations are employed, it makes more sense to begin with the industries (sources of employment change by occupation are discussed in the next section).

Perhaps the best way to approach our analysis is to observe its results. The basic sources of employment change are identified and measured; then we discuss the results and their implications. So in this chapter the reader will be referred to a series of tables that give the detailed results. Since the tables are so detailed (39 industries, 85 occupations) and cover the complete business sector of the Canadian economy, readers with special interests in particular industries or in particular occupations will have their special interests satisfied. But the tabular results are also totalled over all industries and all occupations, so that sources of employment change for the Canadian business sector, taken as a whole, are revealed. Indeed, the total over all industries should yield the same results as the total over all occupations, and this "identity" serves as a powerful "check" on the analysis.

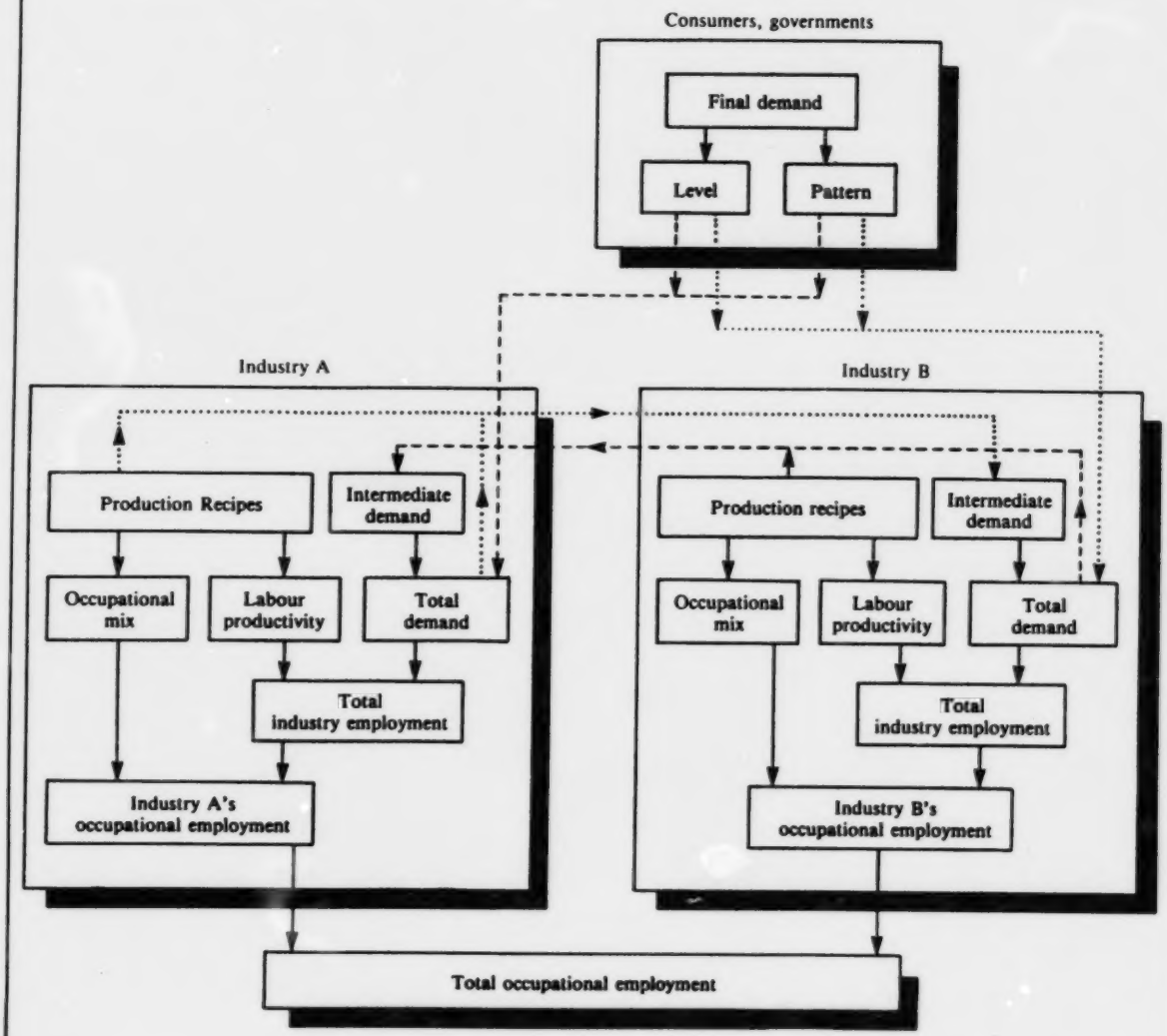
The reader is, therefore, first referred to Table 3-1. The table contains a list of all industries in the Canadian business sector; there are 39 distinct industries in our analysis (government administration, and public education and health excluded) followed by the total for all industries (line 40). The first column merely shows the average employment in the year 1971 for each industry; the second column displays the change in employment over the period 1971-81. (Thus average employment in the year 1981 for any particular industry is equal to the total of the industry's corresponding figures in the first two columns.) Our ultimate purpose, now, is to express the employment change by industry, shown in column (2), as the summation of a number of significant sources that have economic meaning and explanatory value. Table 3-1 accounts for four such explanatory sources, one source in each of the remaining columns of the table. So, for each industry, the summation of columns (3), (4), (5), and (6) equals the cor-

A Guide to Understanding the Translation of Demand and the Production Framework into Industrial and Occupational Employment

Where there is demand for a commodity or service and where there is an individual or organization who takes the initiative to satisfy that demand and establishes a framework by which to do so, a job is created. The nature of the job depends on the nature of the initial demand and the nature of the framework set up to meet it. The accompanying diagram (Figure 3-1) has been prepared to clarify the process by which demand and the production framework follow through to determine employment (both within industries and within occupations). Understanding this system should facilitate understanding the analysis of this chapter.

Figure 3-1

Demand, Production Recipes, Industrial and Occupational Employment – The Linkages



(cont'd.)

Each individual consumer has an endless shopping list of personal requirements – groceries, car repairs, dental care, banking services, dry cleaning. . . . Governments similarly have a long list of public requirements – snow ploughing, garbage removal, education, highway construction, policy formulation. . . . The sum total of all expenditures incurred by consumers and governments (whether they be domestic or foreign) in satisfying their requirements is the LEVEL OF FINAL DEMAND.

Not only do the individual needs of consumers and governments combine to determine the total level of final demand; they also determine the composition of that demand. Collectively, they decide how total final demand is distributed between toothbrushes and bridges, legal services and aircraft. . . . That is, they determine the PATTERN OF FINAL DEMAND.

The level and pattern of final demand appear in the upper right portion of the diagram. They act as catalysts to the system, and it is up to industry to respond to their prompting. For simplicity, we have shown only two industries – Industry A and Industry B. For illustration, we shall let A manufacture computers and B manufacture brooms. For a given level of final demand and with a given proportion of that demand going to computers (brooms), industry will be spurred to produce so many computers (brooms) for consumers and governments.

Each industry has its own framework for handling production – its factory, its machinery, its "recipe" for combining ingredients to come up with a computer or a broom. The PRODUCTION RECIPE indicates the kinds of people it will need to hire – the kinds of skills, qualifications, and education that its workers must possess. Our computer manufacturer will require some engineers, several assemblers, and a few janitors. The broom manufacturer will be staffed by skilled handle makers, several broom binders, and a few individuals to ship and check inventories. The distribution of each industry's employment needs over the various occupations is its OCCUPATIONAL MIX.

The production recipe also determines the quantity of output that any one worker can produce – the LABOUR PRODUCTIVITY.

Finally, the production recipe dictates the types of material inputs and the proportions in which they must be combined. The computer manufacturer will require circuit boards, chips, wire, solder, and a few brooms to keep the place in order. The broom manufacturer will require wood, brushes, and a small computer to assist in shipping and inventories. It is clear that the industries are now interconnected. The production recipe of industry A places a demand on the output of industry B – an INTERMEDIATE DEMAND for the latter's output. Similarly, the production recipe of industry B stipulates inputs from industry A – hence generating intermediate demand for the latter's inputs.

Within each industry, the combination of final demand by consumers and governments and intermediate demand by other industries yields TOTAL DEMAND. The industry sets out to fill this demand, and in accordance with its labour productivity, it will employ the appropriate number of workers – yielding TOTAL INDUSTRY EMPLOYMENT. Total industry employment will be distributed over the various occupations by the occupational mix. This gives INDUSTRY OCCUPATIONAL EMPLOYMENT. Finally, the occupational requirements of all industries, in this case industry A and industry B, will be pooled and will determine total employment within each occupation – TOTAL OCCUPATIONAL EMPLOYMENT.

At any point in time, both the level and pattern of final demand and the production recipes are fixed. Over time, however, they are constantly evolving and changing. As the economy grows, the level of final demand changes. As consumer and government tastes and preferences change, the pattern of final demand changes. As industries take advantage of new knowledge and equipment, production recipes change – the associated occupational mix is altered in favour of one profession or trade over another; labour productivity changes; and intermediate input requirements shift. As the diagram indicates, a new level or pattern of demand, or changes in the production framework, will feed into the system – causing subsequent elements in the chain to adjust to new levels. Ultimately, the change in one of the initial forces will work its way down to a change in total industry employment and total occupational employment. It is the purpose of this chapter to measure the contribution of change in demand and in the production framework (and their components) to change in industrial and occupational employment.

responding employment change found in column (2). Let us now examine each of these explanatory sources in turn.

It is easy to begin with the source embodied in column (6) – "level of final demand." We may think of the final-demand level in terms of the common indicator of Canada's overall economic activity – namely, gross domestic product (GDP). Thus this source shows the impact of changes in GDP (measured in constant prices) from 1971 to 1981 on employment change in each industry, under the assumption that all other sources remain unchanged. (The particular impact of GDP is further clarified in Table 3-2.) From Table 3-1 it is seen that the change in the level of final demand alone was responsible for increasing employment in Canadian agriculture by over 200,000 persons during 1971-81. This source also raised total employment in all industries by about 2,758,000 persons over the same period. Indeed, it is not surprising to learn that the GDP source had

Table 3-1

Change in Industry Employment, by Source, Canada, 1971-81

	Employment, 1971 (1)	Change in employment, 1971-81 (2)	Change in employment because of change in: Labour productivity (3)	Intermediate demand (4)	Pattern of final demand (5)	Level of final demand (6)
			(Number of persons)			
Industry:						
1 Agriculture	502,024	−1,557	−105,929	−16,825	−80,450	201,647
2 Forestry	59,799	715	−15,474	−9,482	1,289	24,382
3 Fishing, hunting, and trapping	20,176	16,006	8,720	1,096	−4,782	10,972
4 Metal mines	61,337	−1,781	−2,336	−18,049	−5,780	24,384
5 Mineral fuels	21,934	16,280	12,195	−4,992	−2,523	11,600
6 Nonmetal mines and quarries	20,102	832	−2,742	−3,075	−1,577	8,226
7 Services incidental to mining	17,923	21,541	−11,676	24,400	−2,062	10,879
8 Food and beverages	220,694	13,666	−41,193	5,991	−42,324	91,192
9 Tobacco products	9,582	−901	−2,343	−743	−1,509	3,694
10 Rubber and plastics	44,928	16,523	−9,119	5,782	−1,149	21,009
11 Leather industries	28,017	−1,805	−5,599	−4,252	−2,923	10,969
12 Textile industries	69,487	−1,898	−22,765	−5,440	−1,561	27,868
13 Knitting mills	23,948	−3,437	−9,652	−1,983	−917	9,115
14 Clothing industries	99,516	−3,363	−26,545	−11,874	−4,630	39,686
15 Wood industries	93,040	20,053	−17,042	−4,231	237	41,088
16 Furniture and fixtures	44,580	9,743	−5,957	−3,820	−204	19,724
17 Paper and allied industries	119,102	10,714	−22,065	−8,458	−8,599	49,837
18 Printing and publishing	85,862	22,302	−28,051	12,110	−459	38,703
19 Primary metal	112,889	10,665	−11,086	−21,102	−4,633	47,486
20 Metal fabricating	138,992	20,017	−19,500	−23,284	2,918	59,883
21 Machinery	71,441	36,964	−27,869	24,141	5,238	35,454
22 Transportation equipment	150,597	27,704	−11,897	−20,952	−5,077	65,630
23 Electrical products	123,450	4,385	−49,240	−11,491	13,126	51,991
24 Nonmetallic mineral products	51,925	3,326	−6,354	−11,874	−43	21,597
25 Petroleum and coal products	14,056	7,396	1,047	1,260	−1,856	6,945
26 Chemical and chemical products	77,445	10,937	−29,328	7,721	−791	33,334
27 Miscellaneous manufacturing	57,971	8,793	−9,176	−9,531	2,344	25,156
28 Construction	557,774	129,422	−63,982	−11,221	−42,724	247,350
29 Transportation and storage	376,319	92,099	−70,637	6,073	−11,063	167,726
30 Communications	144,003	69,357	−93,742	50,550	40,777	71,772
31 Electric power, gas, and other utilities	64,523	32,096	−18,432	11,595	7,263	31,670
32 Wholesale trade	343,942	134,382	−20,484	−3,585	−3,136	161,588
33 Retail trade	929,854	431,469	60,457	−32,107	−45,172	448,290
34 Finance, insurance, and real estate	336,183	216,626	−30,001	43,506	30,804	172,318
35 Education and health services	77,310	40,409	−9,397	443	11,258	38,104
36 Amusement and recreation services	45,351	38,715	−1,843	−1,099	16,828	24,829
37 Services to business management	267,943	303,322	−98,392	201,355	40,887	159,471
38 Accommodation and food services	297,922	215,853	47,938	6,494	5,204	156,217
39 Other personal and miscellaneous services	158,600	131,022	58,469	−4,383	−9,287	86,223
40 Total, all industries	5,940,541	2,098,592	−711,022	158,664	−107,057	2,758,007

SOURCE Based on data from Statistics Canada.

a positive (and, as we shall see, uniform) impact on employment change in each and every industry of the Canadian business sector. When the overall level of economic activity increases, employment is stimulated in all industries.

There is, however, another aspect to final demand (or GDP) that must be considered. Gross domestic product is the total of personal consumption expenditures, government net spending, gross fixed capital formation, and the balance of international trade. These final-

Table 3-2

Percentage Change in Industry Employment, by Source, Canada, 1971-81

Industry:	Change in employment, 1971-81 (1)	Change in employment because of change in: Labour productivity (2)	Intermediate demand (3)	Pattern of final demand (4)	Level of final demand (5)
			(Per cent)		
1 Agriculture	-0.3	-20.5	-3.3	-15.6	39.1
2 Forestry	1.1	-24.8	-15.2	2.1	39.1
3 Fishing, hunting, and trapping	57.0	31.0	3.9	-17.0	39.1
4 Metal mines	-2.9	-3.7	-28.9	-9.3	39.1
5 Mineral fuels	54.8	41.1	-16.8	-8.5	39.1
6 Nonmetal mines and quarries	4.0	-13.0	-14.6	-7.5	39.1
7 Services incidental to mining	77.3	-41.9	87.6	-7.4	39.1
8 Food and beverages	5.9	-17.6	2.6	-18.1	39.1
9 Tobacco products	-9.5	-24.8	-7.9	-16.0	39.1
10 Rubber and plastics	30.7	-17.0	10.7	-2.1	39.1
11 Leather industries	-6.4	-19.9	-15.1	-10.4	39.1
12 Textile industries	-2.7	-31.9	-7.6	-2.2	39.1
13 Knitting mills	-14.7	-41.4	-8.5	-3.9	39.1
14 Clothing industries	-3.3	-26.1	-11.7	-4.6	39.1
15 Wood industries	19.1	-16.2	-4.0	0.2	39.1
16 Furniture and fixtures	19.3	-11.8	-7.6	-0.4	39.1
17 Paper and allied industries	8.4	-17.3	-6.6	-6.7	39.1
18 Printing and publishing	22.5	-28.3	12.2	-0.5	39.1
19 Primary metal	8.8	-9.1	-17.4	-3.8	39.1
20 Metal fabricating	13.1	-12.7	-15.2	1.9	39.1
21 Machinery	40.7	-30.7	26.6	5.8	39.1
22 Transportation equipment	16.5	-7.1	-12.5	-3.0	39.1
23 Electrical products	3.3	-37.0	-8.6	9.9	39.1
24 Nonmetallic mineral products	6.0	-11.5	-21.5	-0.1	39.1
25 Petroleum and coal products	41.6	5.9	7.1	-10.4	39.1
26 Chemical and chemical products	12.8	-34.4	9.0	-0.9	39.1
27 Miscellaneous manufacturing	13.7	-14.2	-14.8	3.6	39.1
28 Construction	20.4	-10.1	-1.8	-6.7	39.1
29 Transportation and storage	21.4	-16.5	1.4	-2.6	39.1
30 Communications	37.7	-51.0	27.5	22.2	39.1
31 Electric power, gas, and other utilities	39.6	-22.7	14.3	9.0	39.1
32 Wholesale trade	32.5	-5.0	-0.9	-0.8	39.1
33 Retail trade	37.6	5.3	-2.8	-3.9	39.1
34 Finance, insurance, and real estate	49.1	-6.8	9.9	7.0	39.1
35 Education and health services	41.4	-9.6	0.5	11.5	39.1
36 Amusement and recreation services	60.9	-2.9	-1.7	26.5	39.1
37 Services to business management	74.3	-24.1	49.3	10.0	39.1
38 Accommodation and food services	54.0	12.0	1.6	1.3	39.1
39 Other personal and miscellaneous services	59.4	26.5	-2.0	-4.2	39.1
40 Total, all industries	29.7	-10.1	2.2	-1.5	39.1

SOURCE Based on data from Statistics Canada.

demand components change in relative importance over the period 1971-81; indeed, the commodity composition of each major component also shifts over time. These aspects are accounted for in column (5) - changes in the "pattern of final demand." Then column (5) measures the impact of this additional source of industry employment change, under the assumption that all other sources (including "level of final demand") remain unchanged. Clearly, the results now shown in column (5) are more interesting. Changes in the pattern of final demand alone tend to decrease employment in Canadian agriculture by over 80,000 persons (the impact is negative). On the other hand, for some industries the impact of this particular explanatory source is positive

– e.g., the communications industries (line 30) and services to business management (line 37); in both cases, this source is responsible for raising employment by about 40,000 persons. Over all industries, changes in the pattern of final demand decrease Canadian employment by 107,000 persons.

Before continuing, it might be noted that the two sources of employment change described by columns (5) and (6) can also be combined into one summary source entitled "changes in final demand" by merely summing the corresponding industry elements of each source. It will also be seen that the absolute impact of column (6) is always greater than that of column (5); nevertheless, the changes exposed by column (5) alone can still be important (see Table 3-2). In particular, it is of interest to see that employment changes in most of the primary and manufacturing industries, and construction, are "adversely" affected by the changes in pattern of final demand; most of the Canadian service industries, on the other hand, experience employment gains as a result of this particular source of employment change.

We now turn to a set of explanatory sources that are distinctly different from "final demand." First of all, consider column (3) – changes in employment because of change in "labour productivity." What essentially does this mean? We are now concerned with the structure of Canadian methods of production. A key aspect of this concern is the productivity of labour (i.e., output per person employed) in the various industries. If labour productivity in a particular industry increases over time and all else remains the same (including total industry output), then employment in that industry will fall. The explanatory source shown in column (3), then, embodies a special measure of labour productivity and its change over the period 1971-81. As a result of this source alone, employment in Canadian agriculture decreased by almost 106,000 persons. In fact, the labour-productivity source of employment change had an "adverse" (negative) impact in almost all industries – one could say that this source, acting alone, is primarily responsible for employment *displacement* in most industries of the Canadian business economy. There are, however, some significant exceptions – e.g., retail trade (line 33), accommodation and food services (line 38), and other personal and miscellaneous services (line 39). Over all industries, the labour-productivity source alone tended to diminish Canadian employment by over 700,000 persons during the period 1971 to 1981.

The fourth (and final) source of employment change, shown in column (4), is also concerned with changes in Canadian methods of production. The production of any industry's output not only requires labour input; it also consumes a "recipe" of raw materials, energy, services, and various capital items charged to operating expenses. These typically involve purchases from other industries and are generally referred to as "demand for intermediate inputs" (they are measured by so-called "input/output statistics"). When Canadian methods of production are subject to change, these changes are usually evident from corresponding changes in intermediate demand, together with the changes in labour productivity already discussed. Consider, then, the results shown in column (4). The results indicate that changes in the demand for intermediate inputs required for total Canadian production, assuming all else is constant, are responsible for a decrease of Canadian agriculture employment equal to almost 17,000 persons during the period 1971-81. In effect, then, there has been a shift away from agricultural commodities as an intermediate input used by Canadian business industries. On the other hand, communications services (line 30) experienced a gain in employment of over 50,000 persons because of this particular source of employment change. So services related to communications have become a more important intermediate input during the relevant time period. Indeed, most of the dramatic increase in employment in services to business management (line 37) – namely, over 300,000 persons; see column (2) – is the result of the rising importance of those services as a purchased (contracted-out) intermediate input by the various industries of the Canadian business economy (compare column (4) with column (2) for line 37). There are other outstanding changes as well, as indicated by column (4).

Before continuing, it should be noted that columns (3) and (4) might be combined into one summary source of employment change, loosely called "changes in production structure" (or "structural change"). It is also of the utmost importance to realize that the four designated explanatory sources are mutually exclusive and exhaustive. This means that each source alone has a clear economic meaning, and the four sources together sum to the change in employment for each industry. There is nothing "left over" to explain.

We now refer the reader to Table 3-2. This table is built upon the results of Table 3-1, but all the results are expressed in terms of percentage changes over the period 1971-81 (rather than number of persons). Thus while Table 3-1 clearly highlights the relative importance of each industry (as measured by number of persons employed), it is somewhat difficult to grasp the relative impacts of the various explanatory sources of employment change, when comparing the different industries, without transforming the basic results to a more comparable standard. Let us first examine the total of all industries in Table 3-2 (line 40). Thus total industry employment increased by almost 30 per cent during the period. The four familiar sources then pro-

vide an explanation of the 30 per cent gain in employment. The change in level of final demand accounts for a 39 per cent increase; the change in labour productivity in column (2) is responsible for a 10 per cent drop in employment; and the other two sources are of minor importance. More generally, structural change accounts for a labour *displacement* equal to about 7.9 per cent of employment while final-demand change accounts for a labour re-employment (or *absorption*) equal to about 37.6 per cent of employment during the period 1971-81.

The benefits of Table 3-2, however, are more clearly seen by observing and comparing the results for the individual industries. It is a notable fact that the change in level of final demand has the *same* percentage impact on employment change in each and every industry. So, percentage changes in individual industry employment, when analysed comparatively, are entirely accounted for by the three remaining explanatory sources. Thus, for example, when we observe that amusement and recreation services (line 36) experienced an employment gain equal to 61 per cent while knitting mills (line 13) experienced an employment loss equal to 15 per cent, then this huge difference of 76 percentage points must be entirely accounted for by 1) labour-productivity (percentage) differences, 2) intermediate-demand differences, or 3) pattern-of-final-demand differences. Indeed, this is precisely the case. There is one final distinction between Tables 3-1 and 3-2 that might also be noted. The total for all industries (last line, Table 3-1) is just that – the simple summation of the results in each column. In the case of Table 3-2, however, the last line is actually a weighted average of all the respective results for the individual industries. The weights are proportional to the relative importance of each industry's employment in the total employment of the Canadian business sector.

Tables 3-1 and 3-2, together, provide 39 distinct "stories" of employment change for the Canadian business sector (one "story" for each industry). In this chapter it is not possible to spell out the stories in any detail. Further detail, though, can be found in the supporting background study. For the present, we cite some examples of the stories that could be told. Reference is once again made to Table 3-2.

Communications services (line 30) is an example of an industry that has experienced above-average employment gains during the period 1971-81. Its employment grew by 38 per cent compared with 30 per cent for the total of all industries. Yet this same industry has been faced with profound changes in its production structure that have raised the industry's labour productivity by 51 per cent. This source alone, compared with the average labour-productivity rise in all industries (about 10 per cent), would lead one to believe that employment in communications would be difficult to maintain. From Table 3-2, then, we learn that employment in the communications industry was maintained; in fact, there was a more-than-average increase because of the extraordinary gains in communications output that stemmed from changes in both intermediate demand (27 per cent) and the pattern of final demand (22 per cent) for that industry's output. On the other hand, metal mines (line 4) experienced a net loss of employment (about 3 per cent) over the period 1971-81, even though the labour-productivity source of employment change was essentially stagnant. Using Table 3-2, we can see that this particular story stems from a depressed market demand for the output of metal mines – both the intermediate demand and (pattern of) final demand for this industry's output were negative and significantly below the corresponding sources of employment change for the total of all industries in the Canadian business economy.

Finally, as mentioned above, some further explanation for these contrasting styles of sources of employment change are given in a more technical background study.

Sources of Employment Change, by Occupation

So far we have distinguished four prime sources of employment change, by industry. In fact, one of the sources (changes in the level of final demand) turns out to be equal for all industries when measured in terms of percentage change (39.1 per cent). Therefore, at least for comparative purposes, there are three essential sources of employment change, by industry. The discussion in the previous section, however, did not distinguish between the different types of employment in the various industries. In effect, we have assumed that the employment mix within each and every industry is the same. This assumption, of course, is not realistic. Moreover, the previous analysis overlooks the fact that certain types of employment in *different* industries may be homogeneous (or, at least, have much in common). Problems of this nature can be resolved, and the necessary distinctions can be made by considering an analysis of employment change by occupation.

In this section we distinguish 85 occupations, again covering all the occupations found in the Canadian business sector. Employment in each industry is composed of various occupations (sometimes as many as 30 to 40), while almost all occupations are to be found in more than one industry (sometimes as many as 20 or 30). In these conditions, then, it is natural to expect sources of employment change by occupation to at least partly

reflect the sources of employment change by industry – depending on the *distribution* of occupational employment among the various industries. This expectation is, indeed, fulfilled in our analysis. But the occupational distinctions also add a new dimension to sources of employment change – namely, the role of changes in "occupational mix" (explained below).

Let us now turn to Table 3-3 (sources of employment change by occupation, measured in terms of "number of persons"). First note that the results totalled over all occupations (line 86) are identical to the previous results totalled over all industries (line 40 of Table 3-1). In order to understand the derivation of sources of employment change by individual occupation, we proceed as follows. Suppose that the occupational mix of employment within each and every industry remained unchanged during the time period 1971-81. Employment as a whole in each industry is, of course, permitted to change; but whatever the change in employment turns out to be, we suppose that the occupational mix in each industry remains constant. In this case, then, the analytical sources of change in occupational employment would, essentially, "coincide" with the previous analysis of change in employment by industry. We would still expose the four previous explanatory sources, but the interpretation of the results is now only a little different. Each occupation, in turn, is affected according to its distribution among the various industries. For example, if employment in a particular industry consists of only one occupation and vice versa, then the analytical sources of employment change for that industry would completely coincide with the analysis for that occupation. More realistically, particular occupations are distributed over different industries. So the explanatory sources for the various occupations would simply reflect the corresponding analysis in the various industries according to the relative importance of the occupational employments in the industries. (This statement will become clearer when we turn to Table 3-4.) Supposing, then, that the occupational mix within industries is constant, the above remarks provide the rationale for the respective results shown in columns (4), (5), (6), and (7) of Table 3-3.

During the period 1971-81, however, the mix of occupations in each industry does change. Some occupations become relatively more important and other occupations become less important within the employed labour force of any industry. Those particular occupations that become relatively more important within an industry would experience a gain in employment. The remaining occupations that become less important would experience a loss of employment. Those factors must be accounted for in order to obtain an exhaustive analysis of sources of change in Canadian occupational employment. This source is precisely accounted for by column (3). Note that the summation of column (3) over all occupations is equal to zero (see line 86). The analysis permits a distinction between changes caused by labour-productivity impacts and changes caused by occupational-mix impacts. This distinction has some important consequences for changes in occupational employment in the presence of technological change.

With this background, it is now possible to briefly highlight some of the results shown in Table 3-3. Column (2) lists the changes in employment by occupation, some of which can also be found in other parts of this document. The managerial occupations (lines 14 to 17) report large absolute increases over the period 1971-81. Changes in employment, in terms of number of persons, for some of the "high-tech" occupations (lines 1 to 3, 5, 26, 35, and 67) are not large, but they begin with relatively small employments in the year 1971 (clarified in Table 3-4). The previous explanatory sources of employment change, as exhibited in the results of columns (4), (5), (6), and (7), require no special comments, since these results ultimately depend on those already explained in Table 3-1, plus our knowledge of the employment distribution of the various occupations across industries. It should again be noted that occupational employment, as analysed in columns (4), (5), (6), and (7), is permitted to change only to the extent that industry employment changes during the period and *not* to the extent that the occupational mix of employment changes within industries during the period.

The additional explanatory source, as shown in column (3), is best interpreted as an additional aspect of "structural change." When Canadian methods of production change, this phenomenon is typically reflected by new occupational staffing patterns (changes in occupational mix in column (3)), as well as by changes in labour productivity (column (4)) and changes in demand for industrial intermediate inputs (column (5)). It is easily seen that all the "high-tech" occupations listed exhibit a positive change (a rise in employment) because of changes in occupational mix. On the other hand, the impact of the additional source is negative (a loss of employment) for some of the low-skilled occupations such as general office clerks (line 32), barbers and personal service workers (line 43), mining workers (line 50), labourers in construction (line 76), truck drivers (line 77), and general labour (line 83). The results, however, are not always "clear-cut" because changes in occupational mix within industries are also affected by the change in product mix within each of the industries of our basic analysis.

The results of Table 3-3 again become clearer once the unit of analysis for the various occupations is transformed to a more standard basis for comparison purposes. This is accomplished in Table 3-4, where all

Table 3-3

Change in Occupational Employment, by Source, Canada, 1971-81

Occupation:	Employment, 1971 (1)	Change in employment, 1971-81 (2)	Change in employment because of change in: Occupational mix (3)	Labour productivity (4)	Intermediate demand (5)	Pattern of final demand (6)	Level of final demand (7)
			(Number of persons)				
1 Electrical engineers	12,568	8,720	2,950	-5,082	2,603	1,652	6,597
2 Other engineers	48,214	27,090	4,874	-10,576	7,672	1,046	24,074
3 Engineering, architectural technicians, and architects	39,092	33,392	10,714	-11,154	10,021	2,372	21,440
4 Draughtsmen	21,458	13,017	519	-5,661	5,835	1,416	10,909
5 System analysts and computer programmers	15,562	17,417	8,695	-4,120	2,668	976	9,198
6 Occupations in natural sciences	28,915	9,952	-1,564	-5,765	4,117	-235	13,398
7 Occupations in law	17,704	18,910	-417	-6,147	12,541	2,578	10,354
8 Occupations in social sciences	10,568	16,058	6,628	-2,672	3,692	1,509	6,901
9 Teaching occupations	30,515	20,729	3,362	-4,494	1,810	4,213	15,838
10 Artistic, recreational, and religious	58,465	58,806	18,466	-13,893	12,929	7,941	33,364
11 Health diagnosis and other medical professions	13,316	7,404	1,662	-443	-203	-249	6,637
12 Nurses, physiotherapists, and health technologists	28,458	25,991	10,903	-4,235	822	2,658	15,844
13 Senior managers	39,561	1,394	-12,672	-5,061	2,592	208	16,327
14 Sales managers	12,078	57,111	45,853	-3,771	1,054	-350	14,324
15 Financial managers	6,447	39,468	29,181	-1,873	2,038	1,192	8,930
16 Production managers	6,812	35,299	31,672	-4,155	-359	-469	8,610
17 Other middle managers	84,122	128,296	84,586	-17,773	7,910	-1,876	55,449
18 Personnel and related management and administration	62,226	19,366	-8,790	-11,501	8,871	2,231	28,556
19 Accountants, auditors	87,278	30,985	-16,891	-14,513	17,340	4,277	40,772
20 Supervisors of clerical occupations	71,802	3,081	-24,312	-11,603	6,457	2,652	29,887
21 Secretaries and stenographers	154,883	66,277	-16,521	-26,558	28,332	6,872	74,152
22 Typists and clerk-typists	51,406	5,096	-18,184	-7,950	6,904	2,474	21,852
23 Bookkeepers and accounting clerks	167,412	147,602	64,010	-24,022	14,178	1,054	92,382
24 Tellers and cashiers	101,778	111,432	46,726	2,105	2,450	475	59,676
25 Other bookkeeping and account-recording	24,195	20,024	4,203	-2,889	3,518	2,097	13,095
26 Electronic data-processing equipment operators	18,782	30,155	18,552	-4,559	2,789	806	12,565
27 Shipping and receiving clerks	60,029	18,655	1,987	-8,365	-765	-1,644	27,442
28 Other material recording and distribution	62,289	40,478	18,149	-7,645	-781	-1,259	32,015
29 Receptionists and information clerks	23,805	24,429	9,927	-3,532	3,441	914	13,678
30 Other reception, mail, and messenger services	54,942	19,919	-5,025	-24,663	13,510	10,001	26,097
31 Telephone operators	23,460	1,583	-9,269	-8,446	5,564	3,638	10,096
32 General office clerks	85,279	-88	-31,591	-11,178	6,005	1,847	34,829
33 Other clerical	85,937	27,871	-10,909	-13,096	9,062	3,200	39,614
34 Supervisors of sales occupations	280,355	8,869	-99,443	483	-940	-6,540	115,310
35 Technical salesmen, related advisors	5,563	3,618	1,420	-1,183	389	132	2,860
36 Commercial travellers	53,068	39,390	21,929	-9,843	629	-1,344	28,019
37 Sales occupations, commodities	392,112	151,089	-16,304	8,503	-7,533	-17,417	183,840
38 Sales occupations, services	67,501	55,232	10,435	-8,207	10,342	6,203	36,459

Table 3-3 (concl'd.)

Occupation:	Employment, 1971 (1)	Change in employment, 1971-81 (2)	Change in employment because of change in: Occupational mix (3)	Labour productivity (4)	Intermediate demand (5)	Pattern of final demand (6)	Level of final demand (7)
			(Number of persons)				
39 Supervisors of service occupations	52,807	43,688	5,110	7,452	1,688	838	28,601
40 Protective service	35,358	17,067	-5,665	-7,176	10,510	2,180	17,219
41 Chefs, cooks, waiters, food preparation	172,993	136,710	12,269	21,915	5,713	4,223	92,590
42 Lodging services	14,085	7,320	-1,882	1,757	307	223	6,915
43 Barbers, personal and apparel services	96,517	35,601	-27,078	22,144	-1,297	-3,304	45,136
44 Janitors	83,888	41,346	-4,024	2,497	1,704	117	41,052
45 Other service occupations	36,140	23,341	660	2,745	1,042	393	18,501
46 Foremen of resource, manufacturing, and equipment operator occupations	192,840	31,094	-13,829	-29,225	-3,924	-5,429	82,501
47 Farmers	248,196	-1,783	-1,027	-52,263	-8,303	-39,702	99,513
48 Nursery, and other farming	238,000	-35,070	-45,231	-42,189	-6,416	-30,797	89,563
49 Fishing, hunting, forestry	56,723	12,171	-3,855	-1,311	-3,272	-4,548	25,157
50 Mining occupations	33,505	2,174	-6,779	-3,215	1,064	-2,762	13,866
51 Metal processing	29,479	12,765	8,334	-4,646	-4,578	-427	14,082
52 Meat cutting and other food processing	81,268	21,582	6,423	-9,973	1,004	-12,383	36,512
53 Textile processing	23,863	-4,551	-3,907	-7,281	-1,704	-575	8,916
54 Other processing	74,211	13,937	654	-12,852	-3,469	-2,766	32,370
55 Machinists	34,258	5,325	-1,825	-5,996	-1,627	-33	14,806
56 Tool and die makers	9,654	1,097	-773	-1,587	-821	156	4,122
57 Other metal machining	27,738	-7,407	-12,532	-3,896	-1,378	293	10,106
58 Welders and flame cutters	56,468	27,583	10,811	-6,847	-3,082	-828	27,529
59 Other machining	73,946	6,325	-8,430	-10,266	-5,642	-453	31,117
60 Electrical and electronic equipment fabricating	29,250	6,415	3,362	-10,767	-1,972	2,655	13,135
61 Sewing machine operators and textiles fabricating	128,644	4,006	-5,639	-25,031	-12,349	-5,701	52,726
62 Metal products fabricating	35,483	18,825	10,026	-5,177	-3,102	-449	17,527
63 Painters - not construction	11,028	9,281	5,463	-1,349	-712	-137	6,017
64 Other fabricating	59,779	26,005	11,056	-9,788	-2,622	-1,201	28,561
65 Auto mechanics	108,321	26,368	-16,099	1,117	-2,763	-4,141	48,254
66 Industrial, farm, construction machinery mechanics	53,027	34,275	21,515	-9,149	-2,860	-2,437	27,206
67 Electronic equipment installation and repair	3,824	6,031	4,094	-2,081	782	679	2,556
68 Other mechanics and repairmen	69,427	20,433	-2,123	-7,910	-50	-1,103	31,619
69 Carpenters	92,866	13,531	-8,409	-10,528	-1,758	-5,632	39,858
70 Electricians	43,006	4,154	-5,513	-5,329	-970	-2,168	18,134
71 Plumbers and pipefitters	40,236	2,921	-6,379	-4,767	-485	-2,218	16,770
72 Excavating, grading, paving	41,216	19,797	9,070	-6,307	-466	-2,507	20,007
73 Electric power, light, wire communication equipment installation	27,162	13,207	1,364	-13,540	6,697	5,259	13,428
74 Other construction trades	106,945	33,616	6,323	-12,656	-2,260	-6,745	48,954
75 Foreman, construction trades	89,939	19,896	-3,111	-12,720	223	-4,313	39,816
76 Labouring, construction trades	71,913	-2,423	-18,336	-7,947	-813	-4,002	28,675
77 Truck drivers	172,360	41,217	-7,319	-22,568	473	-6,021	76,652
78 Bus drivers	22,621	14,055	7,534	-4,790	470	-656	11,496

79 Other transport	70,646	13,687	-4,847	-12,170	1,686	-1,831	30,849
80 Printing trade craft workers	32,438	11,726	2,555	-9,962	4,091	-113	15,154
81 Electronic communication equipment operators, power station operators	29,878	4,510	-4,563	-5,760	1,309	627	12,897
82 Materials handling, packaging	145,434	13,520	-17,904	-20,072	-2,902	-6,757	61,155
83 Labouring and other elemental work	166,496	9,265	-22,037	-26,159	-6,085	-5,553	69,098
84 Inspecting, testing, grading and sampling	56,673	16,134	5,930	-12,823	-2,057	-661	25,744
85 Occupations, n.e.c.	152,039	-16,292	-58,948	-17,039	2,136	-1,597	59,155
86 Total, all occupations	5,940,541	2,098,592	0	-711,022	158,664	-107,057	2,758,007

SOURCE Based on data from Statistics Canada.

Table 3-4

Percentage Change in Occupational Employment, by Source, Canada, 1971-81

Occupation:	Change in employment, 1971-81 (1)	Change in employment because of change in: Occupational mix (2)	Labour productivity (3)	Intermediate demand (4)	Pattern of final demand (5)	Level of final demand (6)
	(Per cent)					
1 Electrical engineers	51.6	17.5	−30.1	15.4	9.8	39.1
2 Other engineers	44.0	7.9	−17.2	12.4	1.7	39.1
3 Engineering, architectural technicians, and architects	60.8	19.5	−20.3	18.3	4.3	39.1
4 Draughtsmen	46.6	1.9	−20.3	20.9	5.1	39.1
5 System analysts and computer programmers	74.0	36.9	−17.5	11.3	4.1	39.1
6 Occupations in natural sciences	29.0	−4.6	−16.8	12.0	−0.7	39.1
7 Occupations in law	71.3	−1.6	−23.2	47.3	9.7	39.1
8 Occupations in social sciences	90.9	37.5	−15.1	20.9	8.5	39.1
9 Teaching occupations	51.1	8.3	−11.1	4.5	10.4	39.1
10 Artistic, recreational, and religious	68.8	21.6	−16.3	15.1	9.3	39.1
11 Health diagnosis and other medical professions	43.6	9.8	−2.6	−1.2	−1.5	39.1
12 Nurses, physiotherapists, and health technologists	64.1	26.9	−10.4	2.0	6.6	39.1
13 Senior managers	3.3	−30.3	−12.1	6.2	0.5	39.1
14 Sales managers	155.7	125.0	−10.3	2.9	−1.0	39.1
15 Financial managers	172.6	127.6	−8.2	8.9	5.2	39.1
16 Production managers	160.1	143.7	−18.8	−1.6	−2.1	39.1
17 Other middle managers	90.4	59.6	−12.5	5.6	−1.3	39.1
18 Personnel and related management and administration	26.5	−12.0	−15.7	12.1	3.1	39.1
19 Accountants, auditors	29.7	−16.2	−13.9	16.6	4.1	39.1
20 Supervisors of clerical occupations	4.0	−31.8	−15.2	8.4	3.5	39.1
21 Secretaries and stenographers	34.9	−8.7	−14.0	14.9	3.6	39.1
22 Typists and clerk-typists	9.1	−32.5	−14.2	12.3	4.4	39.1
23 Bookkeepers and accounting clerks	62.4	27.1	−10.2	6.0	0.4	39.1
24 Tellers and cashiers	72.9	30.6	1.4	1.6	0.3	39.1
25 Other bookkeeping and account-recording	59.7	12.5	−8.6	10.5	6.3	39.1
26 Electronic data-processing equipment operators	93.7	57.7	−14.2	8.7	2.5	39.1
27 Shipping and receiving clerks	26.6	2.8	−11.9	−1.1	−2.3	39.1
28 Other material recording and distribution	49.4	22.1	−9.3	−1.0	−1.5	39.1
29 Receptionists and information clerks	69.8	28.3	−10.1	9.8	2.6	39.1
30 Other reception, mail, and messenger services	29.8	−7.5	−36.9	20.2	15.0	39.1
31 Telephone operators	6.1	−35.9	−32.7	21.5	14.1	39.1
32 General office clerks	−0.1	−35.4	−12.5	6.7	2.1	39.1
33 Other clerical	27.5	−10.8	−12.9	8.9	3.2	39.1
34 Supervisors of sales occupations	3.0	−33.7	0.2	−0.3	−2.2	39.1
35 Technical salesmen, related advisors	49.4	19.4	−16.2	5.3	1.8	39.1
36 Commercial travellers	54.9	30.6	−13.7	0.9	−1.9	39.1
37 Sales occupations, commodities	32.1	−3.5	1.8	−1.6	−3.7	39.1
38 Sales occupations, services	59.2	11.2	−8.8	11.1	6.6	39.1
39 Supervisors of service occupations	59.7	7.0	10.2	2.3	1.1	39.1
40 Protective service	38.7	−12.9	−16.3	23.8	4.9	39.1

41 Chefs, cooks, waiters, food preparation	57.7	5.2	9.2	2.4	1.8	39.1
42 Lodging services	41.4	-10.6	9.9	1.7	1.3	39.1
43 Barbers, personal and apparel services	30.8	-23.4	19.2	-1.1	-2.9	39.1
44 Janitors	39.3	-3.8	2.4	1.6	0.1	39.1
45 Other service occupations	49.3	1.4	5.8	2.2	0.8	39.1
46 Foremen of resource, manufacturing, and equipment operator occupations	14.5	-6.5	-13.7	-1.8	-2.5	39.1
47 Farmers	-0.7	-0.4	-20.5	-3.3	-15.6	39.1
48 Nursery, and other farming	-15.3	-19.7	-18.4	-2.8	-13.4	39.1
49 Fishing, hunting, forestry	18.9	-6.0	-2.0	-5.1	-7.1	39.1
50 Mining occupations	6.1	-19.1	-9.1	3.0	-7.8	39.1
51 Metal processing	35.4	23.1	-12.9	-12.7	-1.2	39.1
52 Meat cutting and other food processing	23.1	6.9	-10.7	1.1	-13.2	39.1
53 Textile processing	-19.9	-17.1	-31.9	-7.5	-2.5	39.1
54 Other processing	16.8	0.8	-15.5	-4.2	-3.3	39.1
55 Machinists	14.0	-4.8	-15.8	-4.3	-0.1	39.1
56 Tool and die makers	10.4	-7.3	-15.0	-7.8	1.5	39.1
57 Other metal machining	-28.6	-48.4	-15.1	-5.3	1.1	39.1
58 Welders and flame cutters	39.1	15.3	-9.7	-4.4	-1.2	39.1
59 Other machining	7.9	-10.6	-12.9	-7.1	-0.6	39.1
60 Electrical and electronic equipment fabricating	19.1	10.0	-32.0	-5.9	7.9	39.1
61 Sewing machine operators and textiles fabricating	3.0	-4.2	-18.5	-9.1	-4.2	39.1
62 Metal products fabricating	42.0	22.3	-11.5	-6.9	-1.0	39.1
63 Painters - not construction	60.2	35.5	-8.8	-4.6	-0.9	39.1
64 Other fabricating	35.6	15.1	-13.4	-3.6	-1.6	39.1
65 Auto mechanics	21.3	-13.0	0.9	-2.2	-3.4	39.1
66 Industrial, farm, construction machinery mechanics	49.2	30.9	-13.1	-4.1	-3.5	39.1
67 Electronic equipment installation and repair	92.1	62.6	-31.8	12.0	10.4	39.1
68 Other mechanics and repairmen	25.2	-2.6	-9.8	-0.1	-1.4	39.1
69 Carpenters	13.3	-8.2	-10.3	-1.7	-5.5	39.1
70 Electricians	8.9	-11.9	-11.5	-2.1	-4.7	39.1
71 Plumbers and pipefitters	6.8	-14.9	-11.1	-1.1	-5.2	39.1
72 Excavating, grading, paving	38.6	17.7	-12.3	-0.9	-4.9	39.1
73 Electric power, light, wire communication equipment installation	38.4	4.0	-39.4	19.5	15.3	39.1
74 Other construction trades	26.8	5.0	-10.1	-1.8	-5.4	39.1
75 Foreman, construction trades	19.5	-3.1	-12.5	0.2	-4.2	39.1
76 Labouring, construction trades	-3.3	-25.0	-10.8	-1.1	-5.5	39.1
77 Truck drivers	21.0	-3.7	-11.5	0.2	-3.1	39.1
78 Bus drivers	47.8	25.6	-16.3	1.6	-2.2	39.1
79 Other transport	17.3	-6.1	-15.4	2.1	-2.3	39.1
80 Printing trade craft workers	30.2	6.6	-25.7	10.5	-0.3	39.1
81 Electronic communication equipment operators, power station operators	13.7	-13.8	-17.4	4.0	1.9	39.1
82 Materials handling, packaging	8.6	-11.4	-12.8	-1.9	-4.3	39.1
83 Labouring and other elemental work	5.2	-12.5	-14.8	-3.4	-3.1	39.1
84 Inspecting, testing, grading and sampling	24.5	9.0	-19.5	-3.1	-1.0	39.1
85 Occupations, n.e.c.	-10.8	-38.9	-11.3	1.4	-1.1	39.1
86 Total, all occupations	29.7	0.0	-10.1	2.2	-1.5	39.1

Source Based on data from Statistics Canada.

results are expressed in terms of percentage changes for each occupation over the period 1971-81. The summation of the five explanatory sources in columns (2), (3), (4), (5), and (6) yields the percentage change in occupational employment, in turn, for each occupation; see column (1). Once more the "final-demand level" explanatory source (column (6)) has a uniformly equal percentage impact on each occupation and is, in fact, also equal to the corresponding column in Table 3-2 (analysis by industry). The occupations with the largest percentage change in employment are typically those with large and positive occupational-mix effects and relatively small (in absolute value) labour-productivity effects (for example, occupations on lines 14 to 17, 24, 29, 63). Occupations with negative percentage changes in employment all experience corresponding negative occupational-mix impacts (occupations on lines 32, 47, 48, 53, 57, 76, and 85). The high-tech occupations, all with large percentage changes in employment, are characterized by both large and positive occupational-mix effects and intermediate-demand effects and by relatively large (in absolute value) percentage impacts from the *displacement* effect of labour-productivity increases. Growth in employment in these occupations ultimately comes from *reabsorption* via the favourable occupational-mix and intermediate-demand effects of new technologies. This is a key result of our analysis of sources of Canadian employment change by occupation. (See Charts 3-1 and 3-2 for further illustration.)

Once again, Tables 3-3 and 3-4, together, imply 85 different stories regarding sources of employment change by occupation. Comparatively speaking, the stories are best told by means of Table 3-4. In this table the source called "level of final demand" has an equal percentage impact on all occupations; it is as if that particular source of employment change becomes "factored out" for comparative purposes. Using Table 3-4 it is also convenient to compare the story behind any particular occupation with the total of all occupations (line 86) – the latter acts as a sort of "average" occupation typifying the whole economy. The reader with special interests in particular occupations can easily follow the results.

But there is more to the analysis than just Table 3-4. As already mentioned, there are intimate connections between the sources of employment change by industry and those by occupation. Once more, these connections are best observed when all results are translated into "percentage changes." Consider, then, Tables 3-2 and 3-4 together. It will be seen that the percentage sources of employment change for the Canadian agriculture industry (Table 3-2, line 1) are identical to those for Canadian farmers (Table 3-4, line 47) *except* for the occupational-mix source that has no counterpart by industry. This result essentially follows from the fact that all Canadian farmers are employed in agriculture. Many other connections are also apparent, although not so clear-cut. For example, it is apparent that the percentage sources of employment change for the (business-sector) industry of education and health services (Table 3-2, line 35) are very similar to those shown for teaching occupations (Table 3-4, line 9) and the main health occupations (Table 3-4, line 12). This is because most members of those occupations are employed in the education and health services industry. The reader is encouraged to identify further connections on the basis of her/his knowledge of the distribution of occupational employment across different industries. These connections are made more explicit and presented in further detail in a forthcoming background study.

Conclusion

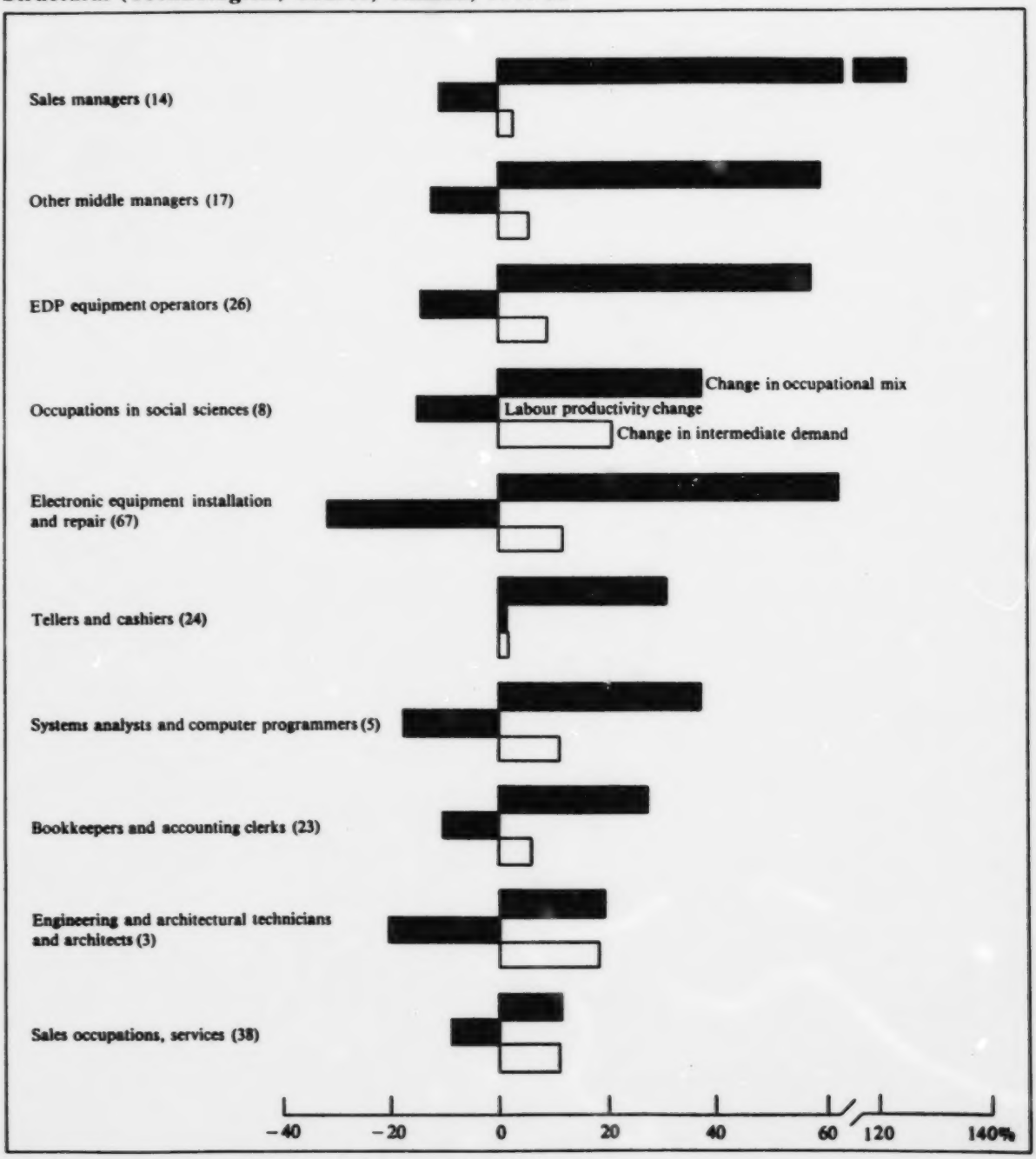
The analysis in this chapter is a simplified version of a more complex procedure spelled out in a background technical study. The simplifications, though, do not detract from the essential validity of the results presented in our tables. All results and corresponding analysis are perfectly valid as they stand. Nevertheless, the reader may benefit from being aware of some "complications" that are missing in the present chapter.

One such complication concerns the explicit role of Canadian international trade. Canadian exports and imports are certainly present in our (simplified) analysis of sources of employment change by industry and occupation. These important aspects of the Canadian economy enter both "final demand" and "intermediate demand" as sources of change. For analytical purposes it is often revealing to distinguish purely "domestic" sources of employment change from sources that are directly affected by international trade. Such a distinction adds clarity to the analysis and aids interpretation of the results. All this can be done; in fact, the background study (mentioned above) contains tables in which both the final-demand and intermediate-demand sources of employment change are disaggregated into "domestic" and "international" effects.

Another complication concerns a breakdown between male and female employment by occupation. It is possible to produce tables somewhat similar to Tables 3-3 and 3-4 of the preceding section, but with male employment and female employment shown separately. If this were done, we would need an additional source of employment change that would account for changes in the male/female mix for each occupation. Once more, the male/female distinction adds clarity to the analysis and aids interpretation. Tables in which the full male/female distinction is drawn can also be found in a forth-

Chart 3-1

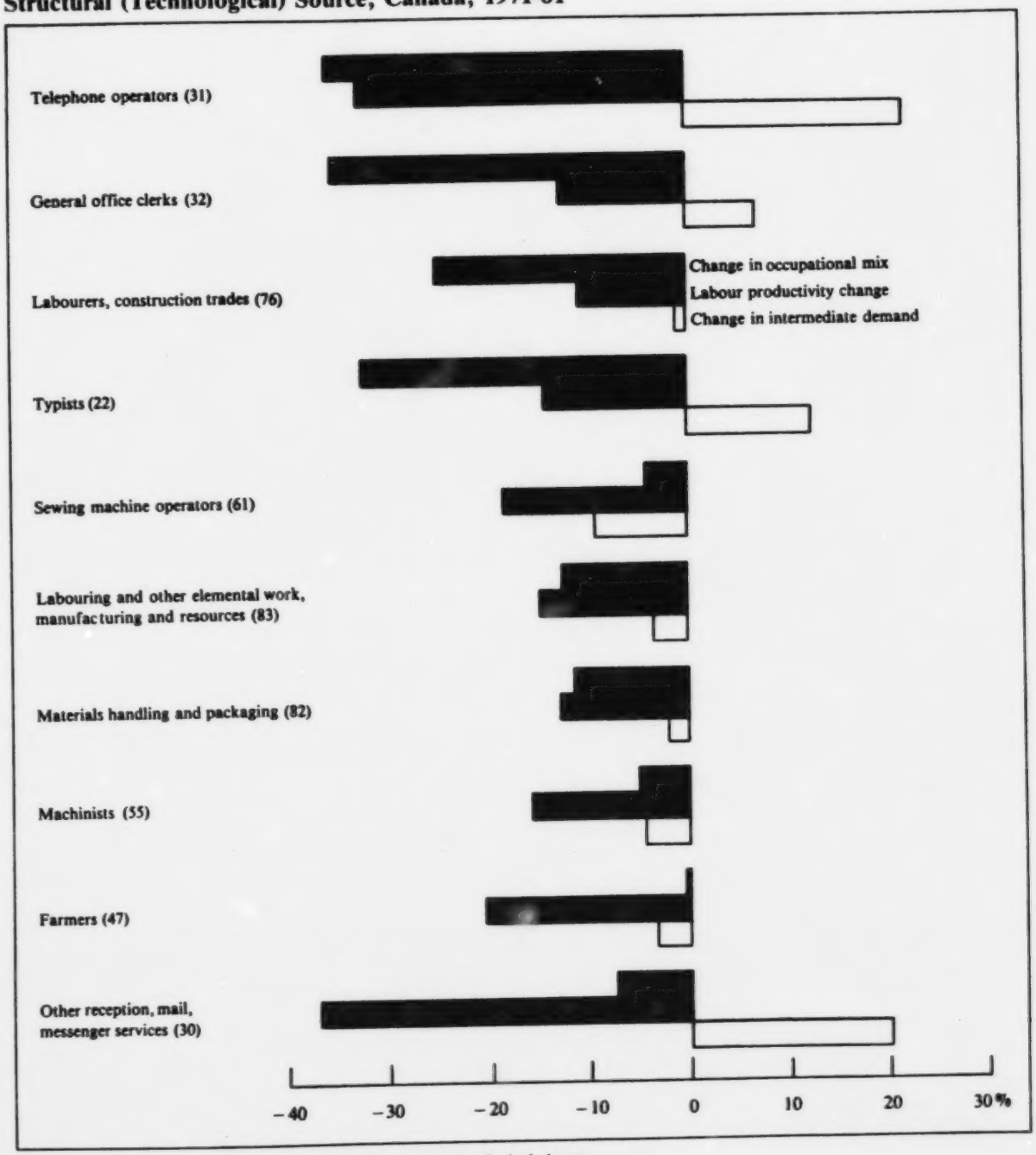
Employment Change Among Major Occupational "Winners,"[1] by Structural (Technological) Source, Canada, 1971-81



1 "Winners" are occupations that gain employment from technological change.
SOURCE See Table 3-4 of this chapter.

Chart 3-2

Employment Change Among Major Occupational "Losers,"[1] by Structural (Technological) Source, Canada, 1971-81



1 "Losers" are occupations that lose employment from technological change.
SOURCE See Table 3-4 of this chapter.

coming technical study. Some preliminary analysis of this phenomenon, together with a supporting table, appears later in this document (see Chapter 9). It should be noted that the additional explanatory source of employment change by occupation and by sex should not be considered as part of "structural change" – and certainly not part of "final-demand change." The additional source, in effect, reflects the influence of particular aspects of labour supply and other behavioural/demographic aspects of the changing Canadian economy.

To conclude this chapter, it might be helpful to point out briefly some highlights of the analysis in the previous sections that are common to many of the industries and corresponding occupations.

Generally speaking, the single most important source of employment growth, as revealed by our analysis, is the overall growth of the economy (as measured by the change in the "level of final demand"). Indeed, in the case of many industries and occupations, even though technological change (or, more broadly, structural change) per se has adverse impacts on employment, the stimulating impact of growth in final demand was sufficient (and, usually, more than sufficient) to reabsorb workers who were "potentially" displaced by the initial change in methods of production. At least this configuration held true during the 1971-81 time period. There is, of course, no guarantee that such a combination of favourable economic events will continue to hold in the future. This matter is further pursued in the next chapter on projections.

Most important, perhaps, is the revelation that even technological change per se need not lead directly to employment displacement. In the analysis for occupational employment, there are three sources of employment change that embody the effects of new technology: 1) labour-productivity change; 2) intermediate-demand change; and 3) changes in occupational mix (staffing patterns). The change in employment for any particular occupation as a result of technological change can be measured as the simple summation of the three distinguished sources. We find that in about 40 per cent of the occupational groups, technological change per se has an employment-enhancing effect. Further analysis reveals that this surprising effect often stems from the phenomenon of "favourable" changes in occupational staffing patterns. In this important set of occupations the "potential" displacement of labour because of productivity gains is often more than *offset* by a "simultaneous" reabsorption of the "same" labour because the particular occupational groups have become a greater proportion of the employed labour force in the Canadian industries affected by technological change. The message, then, is that one should try to consider the full range of technological-change effects before reaching any conclusions with respect to occupational employment displacement.

But there is also the other "side of the coin" that must be considered. We know that the source of employment change identified as "changes in occupational mix," when summed over all occupations, equals zero. So if some occupations experience employment gains because of this particular source, then other occupations must experience employment losses. For these latter occupations, then, the "potential" displacement of labour caused by productivity gains is *reinforced* by a "simultaneous" further displacement of the "same" labour because of unfavourable occupational-mix effects of technological change. In any event, it seems important to have an analysis that is capable of distinguishing the three component sources of employment change that also characterize technological change, as mentioned above.

There is one further point. It seems natural to ask whether there is any systematic relationship between changes in occupational mix and changes in labour productivity by occupation. The answer is no. The occupations experiencing the most rapid productivity increases do not coincide with the occupations which are favourably affected by changes in occupational staffing patterns.

4 Looking Ahead

An investigation into the impact of technological change on the labour market cannot be complete without a view of the future. Just as it is useful to know what has taken place over the last few years, it is also important to be aware of expected employment trends. Armed with such knowledge, labour market participants would be in a better position to identify what job opportunities lie ahead, while policy makers would have a clearer idea of where to place scarce training resources to meet the anticipated skill needs of new technologies.

In this chapter we shall outline our view of the technological future. First, we shall present projections of occupational employment generated by the official occupational forecasting tool of the federal government – namely, the Canadian Occupational Projection System (COPS). But COPS fails to take account of the impact of technological change on the occupational composition of industry employment. The COPS results are, therefore, presented as a point of departure for the rest of the chapter, in which, first, we report some results of the Working with Technology Survey that tapped information on, among other things, businesses' expected acquisitions of, and internal adjustments to, computer-based technologies. Those results showed that contrary to what COPS assumes, changes in establishment staffing patterns have occurred in recent years and that microelectronics-based technologies may have played a major role in that process. Moreover, continued rapid technological change is expected for the 1986-90 period, with a major shift to process automation. This leads us to an alternative modeling effort – MESIM, the *M*icro*E*lectronic *SIM*ulation model – that is capable of explicitly tracking and projecting the occupational implications of the introduction of microelectronics.

The COPS/CANDIDE Link

To generate projections of occupational employment we turned, first, to COPS. The Canadian Occupational Projection System is capable of accommodating a lot of occupational detail at relatively small computational cost.[1] But COPS suffers from the fact that it assumes that occupational shares of industry employment do not change over time and that, therefore, industry changes alone can explain occupational changes.[2] As those who maintain COPS fully recognize and, indeed, are working to correct,[3] this is a rather mechanistic and naive assumption, as it fails to recognize that sometimes quite substantial changes in the occupational mix of industries do occur (see Chapter 3 of this report). For this reason, the COPS results are being presented here for demonstration purposes only.

To produce occupational projections, we first required a set of industry employment projections.[4] This we obtained from the latest CANDIDE reference (base case) scenario. Here, the historical trend toward the shift of employment into the service sector is projected to continue.[5] To measure the technological structure of future employment, we grouped industries into three classes – high-, mid-, and low-tech – based on the extent to which they use high-tech inputs (see Chapter 2 of this report for more details). Table 4-1 shows that the high-tech sector is expected to exhibit stronger employment growth than the rest of the economy to 1996. The next step in the procedure was to link this industry employment forecast to COPS, from which a set of occupational employment projections was obtained.

The expected employment performance of high-tech occupations is of particular interest. These are occupations that either require an in-depth knowledge of the principles and applications of technology or have a high technology content. Despite above-average employment growth in the past, high-tech occupations are not expected to exhibit extraordinary rates of growth in the future (Table 4-2). In fact, the rate of employment growth in some occupational groups, such as those of physical scientists, engineers, and electronic equipment mechanics, is projected to be slower than that in the total economy during the 1987-92 period. By 1992-96, however, some of these groups – notably, physical scientists – are expected to show faster rates of employment growth relative to the total economy.

Rather than suggest that high-tech will not play a very significant role in future employment growth, these results merely underline the above-mentioned weakness inherent in COPS – namely, that the occupational mix of industries is held fixed throughout the projection period. For a more accurate projection of future occupational employment, what is clearly needed is an occupational projection instrument with a variable occupational component.

Table 4-1

Projected Distribution of Employment and Employment Growth, by Technological Sector, Canada, 1987-96

	Employment distribution			Employment growth[1]		
	1987	1992	1996	1987-92	1992-96	1987-96
			(Per cent)			
Technological sector:[2]						
High-tech	53.1	53.9	54.2	1.9	2.2	2.0
Mid-tech	35.6	35.5	35.6	1.5	2.1	1.8
Low-tech	11.3	10.7	10.2	0.5	0.7	0.6
All industries	100.0	100.0	100.0	1.6	2.0	1.8

1 Average annual rate of employment growth (compounded).
2 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top-ranking one-third were considered to be high-tech; the middle one-third, mid-tech; and the lowest one-third, low-tech.
SOURCE Based on CANDIDE 3.0 base-case solution (August 1986), and calculations by the Economic Council of Canada.

Table 4-2

Actual and Projected Employment Growth[1] in Selected High-Tech Occupations,[2] Canada, Selected Years, 1971-96

	1971-81	1987-92	1992-96
		(Per cent)	
Physical scientists	1.7	1.3	2.6
Life scientists	3.8	1.5	1.9
Architects	5.8	1.9	2.8
Engineers	5.9	1.3	2.1
Systems analysts	10.5	1.8	2.3
Mathematicians, etc.	5.8	1.9	2.2
Engineering and architectural technicians and technologists	7.3	1.1	1.9
Radiological technicians	3.7	2.0	3.0
Medical laboratory technicians	6.2	1.9	2.9
EDP equipment operators	11.0	1.8	2.1
Electronic equipment installers, repairers	8.6	1.0	1.5
Precision instrument repairers	5.2	1.3	1.9
High-tech occupations combined	6.6	1.5	2.2
Total economy	3.1	1.6	2.0
High-tech employment change as a proportion of total employment change	7.2	3.9	4.5

1 Average annual rate of growth in employment (compounded).
2 Defined as occupations that require an in-depth knowledge of technologies or that have a high technology content.
SOURCE Based on data from Statistics Canada, Census of Canada, 1971 and 1981; CANDIDE 3.0 base-case solution (August 1986); the Canadian Occupational Projection System (COPS); and calculations by the Economic Council of Canada.

Computer-Based Technologies to 1990

Technological change plays an important role in determining what sorts of skills are needed to meet the needs of society. Technological change, however, can take many forms,[6] and given enough information about individual technologies, it is possible to trace their impacts explicitly, thus giving a more visible face to technological change. Much of the immediate concern about the employment impacts of technological change, in fact, focuses on the computer-based technologies. In order to identify just how far these have diffused throughout Canadian industry, the Economic Council conducted the Working with Technology Survey (WWTS) in 1985 that asked Canadian businesses about their activities in the first half of the 1980s with respect to the introduction of computer-based technologies, both in the office and on the shop floor.[7] Information was also gathered about their plans for the 1986-90 period.

The changes forecasted by the survey respondents in 1985 should be regarded only as indicative of trends. First, investment plans are heavily influenced by external factors, such as the cost of capital and other inputs, the buoyancy of markets at home and abroad, competitive pressures, and the cost and capabilities of the technologies themselves; thus they change through time. Second, based on the experiences reported for the first half of the decade, it is clear that the planning period for the introduction of computer-based technologies is comparatively short, ranging from an average of two years for word processors to close to three years for computer-numerically-controlled machine tools. It is very probable, therefore, that not all installations of

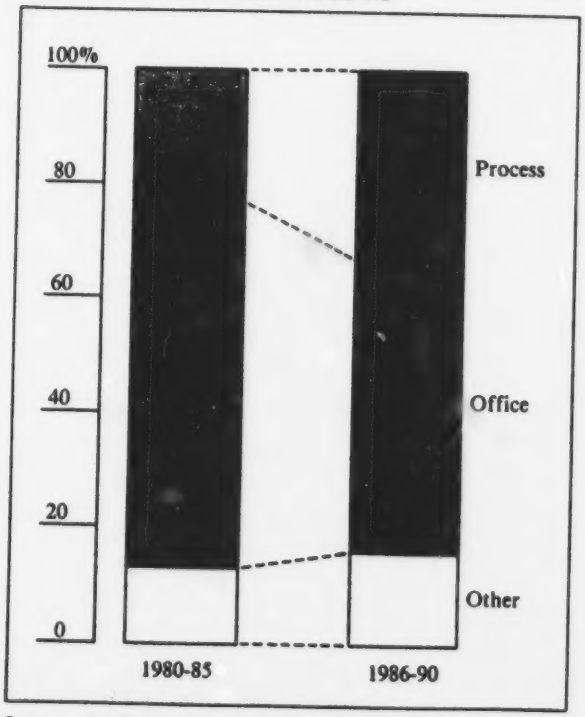
computer-based equipment to 1990 were systematically predicted in 1985. Given that the planning horizons are so similar for the various technologies, however, the plans that were in place in 1985 provide a good indicator of the overall composition of new installations of computer-based technologies to 1990.

In the first half of the 1980s, office-automation technologies accounted for close to two-thirds of all applications reported by respondents to the WWTS. Some shifts are foreseen, however, for the 1986-90 period. While office automation will remain dominant at 51 per cent of all applications, the emphasis will be redirected somewhat toward process automation (Chart 4-1). The shift to more process automation becomes even more pronounced when the plans reported by manufacturers only are considered (Table 4-3). For this sector, the last half of the 1980s will be a mirror image of the first half, with the share of process automation growing from 37 per cent to 52 per cent of all applications and the share of office automation decreasing from 57 per cent to 39 per cent. Growth rates will be highest for computer-aided design (CAD) and computer-aided manufacturing (CAM). Within the office-technologies group, there will also be a shift in all sectors toward increased sophistication and complexity as the share of integrated office networks grows.

Overall, 57 per cent of the survey respondents had plans in place in 1985 to introduce some computer-based technological change before 1990. That previous experiences with computer-based technologies have been positive is suggested by the fact that 62 per cent of those who innovated in the first half of the 1980s planned to do so again in the second half. Furthermore, 42 per cent of those who did not introduce these technologies

Chart 4-1

Distribution of Actual and Projected Computer-Based Technological Change, Canada, 1980-85 and 1986-90



SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

Table 4-3

Distribution of Computer-Based Technological Change, Introduced and Planned, in the Manufacturing Sector, by Type of Technology, Canada, 1980-85 and 1986-90

	Introduced 1980-85	Planned 1986-90
Type of technology:	(Per cent)	
Process	36.7	51.9
Automated material handling	4.4	6.1
Computer numerical control	5.6	5.8
Computer-aided manufacturing	16.3	23.8
Computer-aided design	6.2	10.2
Automated inspection and quality control	4.2	6.0
Office	57.0	38.8
Word processing	15.2	7.5
Personal computers/ workstations	24.1	12.9
Office networks	3.9	7.3
Office applications	13.8	11.1
Other	6.2	9.4
Transportation, communications, and other utilities - specific applications	0.2	0.2
Health - specific applications	-	0.2
Point-of-sale	1.6	3.6
Other	4.4	5.4
Total	100.0	100.0

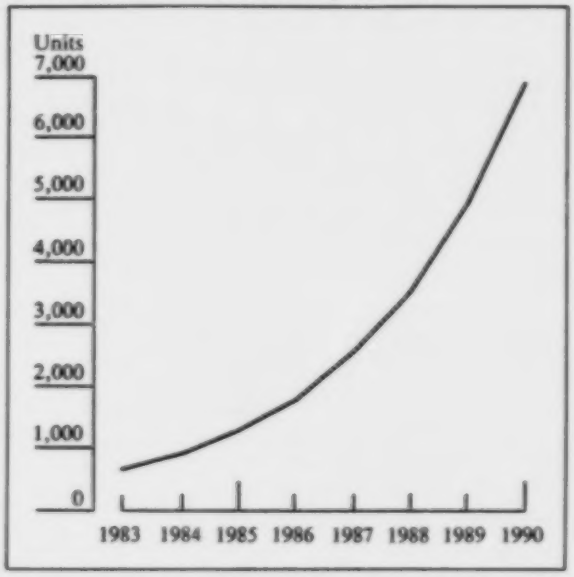
SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

between 1980 and 1985 expected to do so by 1990. As a result, fully 85 per cent of the surveyed establishments will have had direct experience with computer-based technologies during the 1980s. The greatest degree of change in the 1986-90 period is expected in manufacturing; business services; health and social services; finance, insurance, and real estate; and communications and other utilities.

Independent survey evidence provides strong support for the contention that the period 1986-90 will witness steady, large increases in the growth of process automation, particularly CAD/CAM. According to the Evans Research Corporation, the trend here will parallel that observed for computers in the office – namely, to increased integration.[8] Steady growth is expected in the market for both CAD (Table 4-4) and robots (Chart 4-2). It is expected, as well, that other CAM technologies, such as NC (numerical control), automated material handling, and automated test, inspection, and production monitoring will all grow in use. Some of the factors promoting the spread of these technologies are the pressures to increase productivity, reduce labour and inventory costs, improve product quality, increase flexibility, and increase control over the production process. Furthermore, not only is the trend toward increasing integration of computer systems within organizations; it is also toward integration between organizations.

Chart 4-2

Actual and Projected Number of Installed Robots, Canada, 1983-90



SOURCE Based on Evans Research Corporation, "The Canadian CAD/CAM market," ERC Paper No. 65, Toronto, August 1985, p. 68.

Table 4-4

Actual and Projected Sales of Computer-Aided Design (CAD) Equipment, Canada, 1982-90

	Level	Change
	($ millions)	(Per cent)
1982	63	-
1983	97	54
1984	155	60
1985	225	45
1986	315	40
1987	441	40
1988	626	42
1989	889	42
1990	1,262	42

SOURCE Evans Research Corporation, "The Canadian CAD/CAM market," ERC Paper No. 65, Toronto, August 1985, p. 42.

There can be no doubt, then, that technological change is going to be even more pervasive in the future than it has been in the past. But how will this affect the occupational distribution of employment? While the WWTS did not ask employers about their future hiring intentions, it did question them about the levels of employment in different occupations in 1980 and 1985. As shown in Table 4-5, the occupational mix within establishments that introduced computer-based innovations in the 1980-85 period was different from that in non-innovating establishments. The share of professional/technical and other office employees was much larger in innovators, while the share of general manual workers was much lower. And with the continued diffusion of computer-based technologies, there can be little doubt that the occupational composition of employment will show more changes in the future. There is a need, therefore, for an occupational employment projection instrument that is able to take explicit account of changes in the occupational distribution that are associated with new technology – particularly the computer-based technologies – since it is the latter that are having major and far-ranging effects now and into the 1990s.

Table 4-5

Distribution of Employment in Innovating and Non-Innovating Establishments, by Occupational Group, Canada, 1980 and 1985

	Innovators		Non-innovators	
	1980	1985	1980	1985
	(Per cent)			
Type of employee:				
Management	8.0	7.3	8.5	7.9
First-line supervisory	6.8	7.0	5.6	6.0
Professional/technical	11.3	13.3	5.1	5.4
Skilled workers	19.8	18.9	22.5	23.5
General manual workers	32.7	31.4	45.0	43.0
Sales	7.3	7.6	5.9	5.7
Other office employees	14.1	14.5	7.4	8.4
Total	100.0	100.0	100.0	100.0

SOURCE: Based on the Working with Technology Survey, Economic Council of Canada, 1985.

MESIM

In order to answer these very concerns about the future impacts of computer-based technological change (CBTC) on Canadian employment, MESIM was constructed. The model actually yields a wide variety of possible results, both aggregate and disaggregate, over the time period 1981 to 1995. In this section, we focus mostly on the results of *disaggregated* projections, both by industry and by occupation, to the year 1995. The ability of MESIM to project the impact of CBTC at a fine level of industry and occupational detail gives it an absolute and comparative advantage over other Canadian projection models. This is also where some of the most pressing concerns of this report are to be found. Indeed, we shall show detailed results for those particular questions that are of concern to Canadians: 1) Which specific industries and occupations are likely to be most adversely affected by computer-based technological change (CBTC), and 2) which specific industries and occupations are likely to be most favourably affected by CBTC?

Before turning to the detailed projections, we say a few words about the model's methodological and statistical structure. (A complete account of MESIM, including the results of other projections not shown in this document, can be found in a technical background paper.[9]) MESIM combines a macroeconometric model of the Canadian economy with data on both the industrial structure (input/output statistics) and the disaggregated occupational structure (census statistics) of the Canadian labour force. The macro model is based on Canadian economic aggregate data for the historical period 1956-83 but does not embody any policy levers for simulation purposes. The disaggregated industry and occupational structures are based on the period 1971-81 (very similar to the statistical content of Chapter 3 of this report). So the historical data furnish the model with the means of estimating changing economic relationships over time. If these relationships (or trends) are assumed to continue to hold into the future, we then have a projection based on "extrapolation" (usually combined with "outside" demographic assumptions). Indeed, the extrapolation (base case) projection is one of the scenarios we shall investigate in the next section.

But MESIM is capable of doing much more than simply extrapolating trends. Because of the detailed industrial and occupational structure built into the model, MESIM is able to embody specific technological information concerning how Canadian industrial and occupational structures may be modified in the future because of CBTC. The latter phenomenon covers newly developed, but already existing, computer-based automation technology applied in: 1) production processes (robots, CNC machine tools, and CAD/CAM); and 2) offices (mostly information-processing equipment). In fact, the range of new technologies covered by MESIM is very similar to that surveyed by the Economic Council in its WWTS (see preceding section). All this means that MESIM can generate other projections, aside from extrapolation, that lie outside purely historical experience but yet that are based on well-documented technical and engineering knowledge. When this technical knowledge is combined with various economic assumptions (clarified in the next section), we have the basis for a set of alternative scenarios. Our general goal will be to focus on two scenarios, aside from the extrapolation scenario, that are capable of bracketing, and therefore delimiting, the possible future impacts of CBTC on Canadian employment – cumulating the impacts over the time period 1981-95.

Three MESIM Scenarios: Employment Impacts, by Industry

This section will introduce the three basic scenarios used to project Canadian employment to the year 1995. Although each scenario, by itself, is of some interest, we emphasize the value of comparative results for dif-

ferent scenarios. Table 4-6 provides an industrial breakdown of Canadian employment in the base year 1981, together with corresponding employment projections to the year 1995, according to three different scenarios designated 1995A, 1995B and 1995C. There are 36 distinct industries covering the whole business sector of the Canadian economy, followed by the total of all industries. So MESIM, as presented here, is limited to the Canadian business sector (as was the analysis of Chapter 3).

Scenario A is the base case. It is essentially an extrapolation of historical trends, complemented by certain demographic (labour supply) assumptions which are discussed in a background paper describing MESIM. So scenario A projects Canadian industrial employment to the year 1995 on the basis of estimated trends in (disaggregated) labour productivity, intermediate demand, and pattern of final demand; the level of final demand (GDP) is determined by the underlying economic model that relates increases in aggregate labour productivity to increases in aggregate real incomes and resulting increases in aggregate final expenditure. Thus scenario A does not explicitly contain post-1981 CBTC, or at least not to the extent that such technological change falls outside the *observed* historical trends.

Table 4-6

Actual and Projected Employment, by Industry, Canada, 1981 and 1995

		Three scenarios:[1]		
	1981	1995A	1995B	1995C
		(Thousands)		
Agriculture	508.6	343.2	346.1	375.9
Forestry	61.4	45.3	44.3	48.3
Fishing, hunting, and trapping	36.8	53.6	54.1	58.7
Metal Mines	60.6	43.7	40.7	44.3
Mineral fuels	38.7	61.9	58.4	63.4
Nonmetal mines and quarries	21.3	18.3	17.2	18.7
Services incidental to mining	39.7	26.0	22.9	24.9
Food, beverages, and tobacco	246.5	192.9	178.3	193.5
Rubber and plastic products	62.0	132.1	120.6	131.0
Leather industries	26.5	14.2	12.9	14.0
Textile industries	68.4	27.0	23.5	25.5
Clothing industries	118.1	51.4	46.2	50.0
Wood industries	114.8	94.6	83.1	90.5
Furniture and fixture industries	54.9	48.8	43.0	46.6
Paper and allied industries	132.1	106.8	96.8	105.4
Printing and publishing	109.4	64.7	56.6	61.4
Primary metal industries	125.2	116.7	98.8	107.5
Metal fabricating industries	160.0	140.3	99.2	107.8
Machinery industries	108.6	90.3	65.7	71.5
Transportation equipment	181.0	190.2	156.8	170.6
Electrical products industries	128.5	71.5	55.9	60.8
Nonmetallic mineral products	55.6	44.2	38.5	41.8
Petroleum and coal products	21.7	27.2	25.1	27.3
Chemical and chemical products	89.4	53.5	46.3	50.3
Miscellaneous manufacturing	67.2	59.4	51.2	55.5
Construction industry	688.6	793.9	754.6	820.8
Transportation and communications	689.1	495.1	456.1	495.4
Electric power, gas, and other utilities	98.0	107.3	97.9	106.2
Wholesale trade	483.2	528.7	476.8	518.1
Retail trade	1,377.8	1,730.8	1,644.2	1,782.2
Finance, insurance, and real estate	559.3	778.7	713.6	773.9
Education and health services	117.9	143.0	140.6	152.6
Amusement and recreation services	85.5	112.9	112.0	121.3
Service to business management	575.0	855.4	753.6	818.5
Accommodation and food services	520.4	877.7	883.2	957.3
Other personal and miscellaneous services	292.7	477.2	459.7	498.9
Total	8,124.2	9,018.8	8,374.8	9,090.2

1 1995A designates the extrapolation scenario (to the year 1995); 1995B designates the displacement scenario without re-employment; and 1995C designates the displacement scenario with re-employment.

Source: Based on simulation results of MESIM.

Scenario B, on the other hand, is explicitly built on post-1981 CBTC, both observed and projected. So in scenario B, the industrial employment projections of scenario A are modified by superimposing new sets of labour productivity trends and intermediate demand trends that reflect expected CBTC. There are two aspects of this scenario that must be stressed: 1) the rate of diffusion of CBTC is chosen to be "high" in this particular scenario, and 2) the level of final demand (or GDP) is constrained to be the same as that in scenario A. In other words, scenario B does not permit the labour productivity gains earned from CBTC to *feed back* to increased real incomes and to increased real (final) expenditures. The gains in labour productivity derived from CBTC simply result in labour displacement, with no possibility for re-employment.

Scenario C is essentially the same as scenario B except that the classical feedback mechanism *is* permitted to work – in fact, permitted to work perfectly. The labour productivity gains resulting from CBTC raise Canadian real incomes and real final expenditure because "potentially" displaced workers are "simultaneously" re-employed, using the new technology and satisfying new patterns of final demand at a new (and higher) level of Canadian real income and expenditure. In effect, the

Table 4-7

Projected Labour Displacement and Re-Employment,[1] by Industry, Canada, 1981-95

	Displacement	Re-employment	Proportion of employment in 1981	
			Displacement	Re-employment
	(Thousands)		(Per cent)	
Agriculture	−2.9	29.8	−0.6	5.9
Forestry	0.9	3.9	1.5	6.4
Fishing, hunting, and trapping	−0.5	4.6	−1.3	12.6
Metal mines	3.0	3.6	5.0	6.0
Mineral fuels	3.5	5.0	9.0	12.8
Nonmetal mines and quarries	1.2	1.5	5.5	7.2
Services incidental to mining	3.1	2.0	7.8	5.1
Food, beverages, and tobacco	14.6	15.2	5.9	6.2
Rubber and plastic products	11.6	10.4	18.7	16.8
Leather industries	1.3	1.1	4.9	4.0
Textile industries	3.5	2.0	5.2	2.9
Clothing industries	5.2	3.8	4.4	3.2
Wood industries	11.5	7.4	10.0	6.4
Furniture and fixture industries	5.8	3.7	10.6	6.7
Paper and allied industries	10.0	8.5	7.5	6.5
Printing and publishing	8.1	4.8	7.4	4.4
Primary metal industries	17.9	8.8	14.3	7.0
Metal fabricating industries	41.1	8.7	25.7	5.4
Machinery industries	24.7	5.8	22.7	5.4
Transportation equipment	33.5	13.8	18.5	7.6
Electrical products industries	15.6	4.8	12.1	3.8
Nonmetal mineral products	5.7	3.4	10.2	6.0
Petroleum and coal products	2.1	2.2	9.5	10.0
Chemical and chemical products	7.2	4.0	8.0	4.5
Miscellaneous manufacturing	8.2	4.3	12.2	6.4
Construction industry	39.3	66.2	5.7	9.6
Transportation and communications	39.0	39.3	5.7	5.7
Electric power, gas, and other utilities	9.4	8.3	9.6	8.5
Wholesale trade	51.8	41.2	10.7	8.5
Retail trade	86.6	138.0	6.3	10.0
Finance, insurance, and real estate	65.1	60.3	11.6	10.8
Education and health services	2.4	12.0	2.0	10.2
Amusement and recreation services	0.9	9.3	1.0	10.9
Service to business management	101.8	64.8	17.7	11.3
Accommodation and food services	−5.6	74.1	−1.1	14.2
Other personal and miscellaneous services	17.5	39.2	6.0	13.4
Total	644.0	715.4	7.9	8.8

1 Displacement is the difference between scenarios A and B of Table 4-6; and re-employment is the difference between scenarios C and B.
SOURCE Based on Table 4-6 of this report.

labour-market-adjustment problems are completely discounted. The two scenarios, B and C, therefore provide two extreme views of the impact of CBTC on Canadian employment. But the two scenarios also furnish specific estimates of labour displacement and labour re-employment opportunities (by industry) that allow us to discuss and judge the importance of the related labour-market-adjustment problems (see Tables 4-6 and 4-7).

Table 4-6 shows that total employment over all industries in scenario 1995B (labour displacement with no re-employment) is only slightly larger than total employment observed in the base year 1981. So the potential labour-displacement problem is certainly serious on the aggregate. Scenario C, however, shows much higher employment – higher in fact than in scenario A.

The first column of Table 4-7 shows the extent of possible labour displacement for each industry in the Canadian business sector. The estimates are formed by taking the simple difference between the results, industry by industry, of scenario A and scenario B. By far the most important reason for labour displacement in MESIM is the enhanced industrial labour productivity of CBTC in scenario B, though shifts in industrial intermediate demand also play a role. So it is evident that a total of almost 645,000 Canadian workers could potentially be displaced by CBTC – this is *cumulative* displacement over the time period 1981-95. The displacement represents about 7.9 per cent of total employment in the base year 1981. Looking down column 1 of Table 4-7, it is also evident that potential labour displacement is highly uneven across industries. For example, over 40,000 workers are affected in metal fabricating industries; 34,000, in transportation equipment industries; over 85,000, in retail trade; and over 100,000 in services to business management. On the other hand, many Canadian industries are barely touched by CBTC labour displacement, according to MESIM – e.g., forestry; metal mines; and amusement and recreation services. (In three industries, particularly accommodation and food services, the labour displacement is actually negative, a result discussed in the next section, dealing with occupations.)

Of course, looking at labour displacement for each industry does not tell the whole story, since the industries' base employment in 1981 also varies widely. Column 3 of Table 4-7 expresses each industry's labour displacement as a percentage of its employment in the base year 1981. It is now evident that some Canadian industries are (relatively) hard hit by CBTC, as measured under the assumptions of scenario B. Four industries – namely, rubber and plastic products; metal fabricating; machinery; and transportation equipment – all experienced employment losses equal to at least 18 per cent of their total employment in 1981. Retail trade, though experiencing the second largest number of displaced workers, is really better-off than average; its displacement equaled only about 6 per cent of total employment in 1981 (below the 7.9 per cent displacement for all industries taken together).

The second column of Table 4-7 displays the labour re-employment opportunities for each industry. Here, the estimates are formed by taking the simple difference between the results of scenario C and those of scenario B. So, permitting the traditional feedback mechanism to work perfectly raises total employment by about 715,000 workers, which is more than sufficient to *reabsorb* the original labour displacement of approximately 645,000 workers.

The impact of re-employment also varies greatly from industry to industry, in terms of both (absolute) number re-employed and percentage of 1981 base employment levels. Much of the re-employment is concentrated in the service industries: wholesale trade; retail trade; services to business management; accommodation and food services; personal and miscellaneous services; and construction. In the cases of many important industries, there is, indeed, a truly remarkable *coincidence* between the impact of labour displacement and that of labour re-employment. See, for example, the transportation and communications industry. This coincidence is a major factor in resolving the potential problems of labour adjustment. But there are also cases where the "coincidence" does not occur. For example, metal fabricating; machinery; and transportation equipment experience significant *net* job losses (displacement is significantly greater than re-employment); a similar problem appears to exist for services to business management. On the other hand, there are some industries where potential *net* job expansion might occur (re-employment is significantly greater than displacement): accommodation and food services; personal and miscellaneous services; and, perhaps, amusement and recreation services.

All of this is a view, by industry. But a sharper focus on labour-market problems relating to the matching or mismatching of job losses with new job opportunities is afforded by viewing the scenario results of MESIM in terms of occupations.

Three MESIM Scenarios: Employment Impacts, by Occupation

We already know from Chapter 3 that historical sources of employment growth by occupation are closely related to historical sources of employment growth by industry. There was, however, one source of employ-

ment growth by occupation that had no counterpart by industry. This source involved changes in "occupational mix" within individual industries. It might, then, be helpful to the reader to know something about how changes in occupational mix are treated in the occupational projection scenarios of MESIM.

In scenario A, MESIM does not extrapolate "trends" in changes in occupational mix. The reasons for this are a little technical, but basically it is not possible to identify such trends from the limited historical data; observations for only 1971 and 1981 are available. In scenarios B and C, MESIM does permit changes in occupational mix that reflect CBTC. But there is no way to distinguish them from changes in labour productivity. This, of course, is a limitation of MESIM that we must bear in mind. With this background we now examine the results in four new tables.

The first set of new tables, Tables 4-8 and 4-9, are respectively analogous to the previous Tables 4-6 and 4-7. We show 11 summary groups of occupations - a sort of "bird's-eye view" of employment impacts, by occupation. From Tables 4-8 and 4-6 it is seen that the employment impacts totalled over all occupations equal the employment impacts totalled over all industries. One occupation, machining and related occupations, turns out to have very little employment in scenarios B and C of Table 4-8. This, of course, is an important economic result, and we shall offer further interpretation of this result later within the context of detailed occupations. It should be noted, however, that employment *levels*, by occupation (or industry), are not to be regarded as the primary feature of MESIM.

Once again, our main interest falls within the table that shows labour displacement and labour re-employment by occupation - namely, Table 4-9. Note that some occupations exhibit a *negative* displacement - or, in other words, employment growth - because of CBTC, according to MESIM: service occupations; primary occupations; and construction trades and transportation equipment operators. This usually means that there is no available engineering and technical knowledge that would enable estimation of the direct impact of CBTC on those particular occupations. So, direct labour displacement for those occupations actually equals zero. On the other hand, they *are* affected by indirect labour creation following the adjustment of intermediate and final-demand patterns to the new CBTC that characterizes scenario B. This indirect labour creation is then measured in the tables by a negative displacement of labour. (See further discussion below and supporting technical study.)

It is now evident that there are some potential problems facing the Canadian labour market as a result of CBTC. Over 70 per cent of (net) labour displacement (the difference between scenarios A and B) falls within two summary occupations: clerical occupations; and machining and related occupations. Labour re-employment, by occupation (the difference between

Table 4-8

Actual and Projected Employment, by Summary Occupation, Canada, 1981 and 1995

		Three scenarios:[1]		
	1981	1995A	1995B	1995C
Occupations:		(Thousands)		
Managerial, administrative, and related	548.9	625.5	577.8	627.3
Professionals	597.3	692.8	656.1	712.2
Clerical	1,557.9	1,766.1	1,550.6	1,682.8
Sales	1,081.0	1,316.0	1,274.5	1,382.1
Service	851.2	1,311.3	1,344.4	1,457.8
Primary	656.5	503.7	512.3	556.5
Processing	405.0	347.1	321.2	348.9
Machining and related	272.9	269.0	11.5	12.6
Product fabricating, assembling, and repairing	813.1	804.9	747.0	811.0
Construction trades and transport equipment operators	1,025.7	1,087.9	1,112.1	1,208.7
Material handling, equipment operators, and crafts	314.7	294.5	267.3	290.3
Total	8,124.2	9,018.8	8,374.8	9,090.2

1 1995A designates the extrapolation scenario (to the year 1995); 1995B designates the displacement scenario without re-employment; and 1995C designates the displacement scenario with re-employment.

Source: Based on simulation results of MESIM.

Table 4-9

Projected Labour Displacement and Re-Employment,[1] by Summary Occupation, Canada, 1981-95

Occupations:	Displacement	Re-employment	Proportion of employment in 1981	
			Displacement	Re-employment
	(Thousands)		(Per cent)	
Managerial, administrative, and related	47.7	49.5	8.7	9.0
Professionals	36.7	56.1	6.1	9.4
Clerical	215.5	132.2	13.8	8.5
Sales	41.5	107.6	3.8	10.0
Service	−33.1	113.4	−3.9	13.3
Primary	−8.6	44.2	−1.3	6.7
Processing	25.9	27.7	6.4	6.8
Machining and related	257.5	1.1	94.4	0.4
Product fabricating, assembling, and repairing	57.9	64.0	7.1	7.9
Construction trades and transport equipment operators	−24.2	96.6	−2.4	9.4
Material handling, equipment operators, and crafts	27.2	23.0	8.6	7.3
Total	644.0	715.4	7.9	8.8

1 Displacement is the difference between scenarios A and B of Table 4-8; and re-employment is the difference between scenarios C and B.
Source Based on simulation results of MESIM.

scenarios B and C), is much less concentrated. In fact, judging from column 4 of Table 4-9, showing re-employment as a percentage of 1981 base employment, by occupation, the re-employment process is, with one major exception, remarkably uniform. The services occupations experience the largest gain by this measure – i.e., a re-employment gain significantly greater than average (13.3 per cent versus the average of 8.8 per cent for all occupations); machining and related occupations make by far the lowest re-employment gain by this measure (0.4 per cent). Also note that clerical occupations experience a significant *net* loss of employment: displacement is greater than re-employment. But this particular impact is not as severe as the extreme situation with respect to machining and related occupations. Employment in the latter set of occupations is almost eliminated by displacement, and there are no significant re-employment opportunities. Conversely, occupations in sales, services, and construction trades are the big "winners." There is significant *net* job expansion: re-employment is greater than displacement or re-employment adds to labour creation when displacement is negative.

Analysis of employment impacts of CBTC at a more detailed occupational level can be found in Tables 4-10 and 4-11. Altogether, the analysis distinguishes 76 individual occupations, and the detailed occupations are grouped to correspond with the summary occupations shown above.

Table 4-10 is the detailed counterpart of the previous Table 4-8 and requires no general comments. It should be noted, though, that the occupation called "other occupations in architecture and engineering" (mostly, draughtspersons) turns out to have negligible employment according to both scenarios B and C. We will comment on this again shortly. From Table 4-10 it is possible to show proportions of total employment by occupation, but these proportions would all be very small in a context with 76 individual occupations. Finally, Table 4-11 is the counterpart of the previous Table 4-9; Table 4-11 probably contains the most interesting results of the MESIM model, but these results must be interpreted with care. We shall now provide some guidelines to Table 4-11.

First, note that MESIM estimates direct labour displacement following CBTC for only 40 of the 76 distinct occupations. This is the detailed counterpart of Table 4-9, where MESIM estimates direct displacement for only 8 of the 11 summary groups of occupations. For each of those eight summary groups, all the component occupations are permitted to reflect labour displacement *except* in the case of "professionals"; here, displacement only affects two detailed occupations – namely, "other occupations in architecture and engineering" and "occupations in mathematics, statistics, systems analysis, and related fields." So, again, these limitations must be borne in mind. MESIM does not embody technical knowledge relating to the direct

impact of CBTC on, for example, teaching and health occupations in the private sector of the Canadian economy. Nevertheless, the two detailed occupations within "professionals" that are analysed by the model furnish important results.

It has already been noted that employment in "other occupations in architecture and engineering" (mostly draughtspersons) becomes negligible in scenario B; that is because this scenario represents a decidedly high rate of diffusion for CBTC. So, draughtspersons are virtually eliminated in terms of employment over the time period 1981-95 (the percentage displacement, column 3, is actually greater than 100 per cent). The latter results are measured cumulatively. Also note that even following higher real incomes and expenditures, reemployment opportunities within this occupation are close to zero. These particular results, though, are exaggerated and should not be interpreted literally. They reflect, instead, the rather extreme assumptions of a very high rate of CBTC diffusion.

The other component of "professionals" – namely, "occupations in mathematics. . ." (mostly computer scientists) – also requires careful interpretation. Here, labour displacement, according to scenario B, is significantly negative (– 65,400 in column 1 of Table 4-11). What does this mean? If labour displacement is signifi-

Table 4-10

Actual and Projected Employment, by Detailed Occupations, Canada, 1981 and 1995

		Three scenarios:[1]		
	1981	1995A	1995B	1995C
		(Thousands)		
Detailed occupations:				
Managerial, administrative, and related				
Managers and administrators	367.3	403.5	373.9	405.9
Occupations related to management and administration	181.6	222.0	203.9	221.4
Professionals				
Physical sciences	25.4	27.3	27.8	30.2
Life sciences	10.5	10.9	11.0	12.0
Architects and engineers	109.4	122.1	124.7	135.5
Other occupations in architecture and engineering	94.7	108.0	0.1	0.1
Mathematics, statistics, systems analysis, and related	36.8	39.9	105.3	114.3
Social sciences	10.7	12.8	12.9	14.0
Social work and related fields	14.5	20.9	21.0	22.8
Law and jurisprudence	35.9	52.7	52.6	57.1
Library, museum and archives, religion and other occupations in social sciences and related fields	6.0	7.4	7.5	8.1
University teaching and related occupations	3.7	4.5	4.5	4.9
Elementary and secondary school teaching and related occupations	27.8	33.8	33.9	36.8
Other teaching and related occupations	20.9	25.3	25.5	27.7
Health diagnosing and treating occupations	8.3	8.3	8.4	9.1
Nursing, therapy and related assisting occupations	34.9	42.1	42.5	46.1
Other occupations in medicine and health	33.1	38.2	39.0	42.3
Fine and commercial art, photography, and related	51.7	63.8	64.7	70.2
Performing and audiovisual arts	28.5	25.6	25.3	27.4
Occupations in writing	26.4	24.3	23.9	25.9
Sports and recreation	18.1	24.9	25.5	27.7
Clerical				
Stenographers and typists	287.3	349.2	305.8	332.0
Bookkeeping, account-recording, and related	617.8	764.6	680.7	738.4
Office machine and electronic data-processing-equipment operators	64.6	72.3	58.9	64.0
Material recording, scheduling, and distributing	206.9	215.5	178.5	193.8
Library, file and correspondence clerks, and related	18.9	22.4	18.0	19.6
Reception, information, mail, and message distribution	165.1	121.3	100.0	108.5
Other clerical and related	197.3	220.8	208.7	226.5

Table 4-10 (cont'd.)

	1981	Three scenarios:[1] 1995A	1995B	1995C
		(Thousands)		
Sales				
Sales occupations, commodities	906.5	1,087.0	1,061.3	1,150.9
Sales occupations, services	143.2	193.2	178.7	193.8
Other sales occupations	31.3	35.8	34.5	37.4
Service				
Protective service occupations	58.0	77.3	78.1	84.8
Food and beverage preparation and related services	377.4	613.9	625.3	677.7
Occupations in lodging and other accommodation	62.6	101.8	103.4	112.1
Personal service	102.4	159.5	166.9	181.1
Apparel and furnishings service	35.7	53.9	56.4	61.2
Other service	215.1	304.9	314.3	340.9
Primary occupations				
Farmers	240.9	162.5	164.8	179.0
Farm management	37.7	25.5	25.8	28.0
Other farming, horticultural, and animal husbandry	226.1	170.5	173.3	188.2
Fishing, hunting, trapping and related	38.0	50.6	51.7	56.1
Forestry and logging	52.5	40.8	41.8	45.5
Mining and quarrying, including oil and gas field	61.3	53.8	54.9	59.7
Processing occupations				
Mineral ore treating	7.9	6.8	6.4	6.9
Metal processing and related	67.1	61.8	60.8	66.2
Clay, glass, and stone processing, forming, and related	16.1	14.2	13.2	14.4
Chemicals, petroleum, rubber, plastic, and related material processing	40.1	40.0	36.2	39.3
Food, beverage, and related processing	147.2	136.5	124.2	134.7
Wood processing, except paper pulp	41.5	34.8	32.3	35.1
Pulp and papermaking, and related	42.1	34.2	31.4	34.2
Textile processing	36.2	14.5	12.8	13.9
Other processing	6.8	4.3	3.9	4.2
Machining and related occupations				
Metal machining	82.4	76.6	3.3	3.6
Metal shaping and forming, except machining	154.6	158.3	6.8	7.4
Wood machining	11.9	10.5	0.6	0.6
Clay, glass, stone, and related material machining	8.8	8.3	0.2	0.3
Other machining and related	15.2	15.3	0.6	0.7
Product fabricating, assembling, and repairing				
Fabricating, assembling: metal products, n.e.c.	84.6	84.3	84.3	91.7
Fabricating, assembling, installing, and repairing: electrical, electronic, and related equipment	111.6	94.4	85.9	93.3
Fabricating, assembling, and repairing: wood products	36.6	34.0	32.0	34.7
Fabricating, assembling, and repairing: textile, fur, and leather products	159.0	112.3	102.6	111.3
Fabricating, assembling, and repairing: rubber, plastic, and related products	34.1	60.4	56.8	61.7
Mechanics and repairmen, n.e.c.	313.2	346.7	316.7	343.7
Other product fabricating, assembling, and repairing	74.0	72.8	68.7	74.6

Table 4-10 (concl'd.)

	1981	Three scenarios:[1] 1995A	1995B	1995C
		(Thousands)		
Construction trades and transport equipment operators				
Excavating, grading, paving, and related occupations	91.6	99.7	102.0	110.9
Electrical power, lighting, and wire communications equipment: erecting, installing, and repairing	115.8	95.8	95.8	104.1
Other construction trades occupations	445.9	504.9	518.6	563.9
Air transport operating	13.8	13.9	14.2	15.4
Railway transport operating	27.8	27.6	28.1	30.6
Water transport operating	13.9	14.2	14.5	15.7
Motor transport equipment operating	316.9	331.8	338.9	368.1
Material handling, equipment operators, and crafts				
Material handling and related occupations, n.e.c.	207.6	203.4	186.1	202.1
Printing and related	55.9	38.9	34.2	37.2
Stationary engine and utilities equipment operating	34.2	34.7	31.3	34.0
Electronic and related communications equipment, n.e.c.	7.8	4.4	3.6	3.9
Other crafts and equipment operating occupations, n.e.c.	9.2	13.1	12.1	13.1
Total	8,124.2	9,018.8	8,374.8	9,090.2

1 1995A designates the extrapolation scenario (to the year 1995); 1995B designates the displacement scenario without re-employment; and 1995C designates the displacement scenario with re-employment.

SOURCE Based on simulation results of MESIM.

cantly negative, then there is direct job creation following CBTC. In this case, computer scientists experience a direct gain in employment largely because of the favourable "occupational mix" source of employment change. The positive impact of this source is sufficient to outweigh the (implicit) negative impact of labour productivity growth for this particular occupation. No other detailed occupation, according to MESIM, displays such direct job creation (rather than displacement). This, of course, is a limitation of the model, as pointed out at the beginning of this section: the two technological sources of employment change are not distinguished. It should be noted again that other detailed occupations also experience labour creation (negative displacement); in all these cases, however, the effect stems from relatively small economic adjustments of the model rather than favourable changes in occupational mix.

To complete this section, we merely point out some of the highlights of Table 4-11. Labour displacement – and thus the potential for labour unemployment – is largely concentrated in a relatively small number of occupations. Indeed, this statement is valid in terms of both absolute numbers (column 1) and percentages of 1981 base employment, by occupation (column 3). The most adversely affected occupations are draughtspersons and the various machining and related occupations. The clerical occupations are also adversely affected. On the other hand, the labour re-employment opportunities are much more diffuse, with some exceptions. One exception, of course, is computer scientists, where job creation directly caused by CBTC plus indirect re-employment results in a cumulative increase in employment of 200 per cent over the base period. Other individual occupations offering above-average re-employment opportunities are: food and beverage preparation, and related services; personal service occupations; miscellaneous service occupations; sales occupations for commodities; and occupations in lodging and other accommodation. Again, when labour displacement is negative, this job creation adds to the re-employment opportunities following higher real income and expenditure.

So, there are some serious problems of labour market adjustment as a result of the potential mismatch of labour displacement and labour re-employment, by occupation. But it should also be noted that there are many important occupations where the *magnitude* of labour displacement and re-employment coincides. By comparing columns 1 and 2 of Table 4-11, it is readily seen that such favourable coincidence occurs within: managerial, administrative, and related occupations; clerical occupations (though with *net* job loss); processing occupations; product fabricating, assembling, and repairing occupations; and material-handling, equipment operators and crafts. This does not mean, however, that labour-market-adjustment problems actually

Table 4-11

Projected Labour Displacement and Re-Employment,[1] by Detailed Occupations, Canada, 1981-95

Detailed occupations:	Displacement	Re-employment	Proportion of employment in 1981	
	Displacement	Re-employment	Displacement	Re-employment
	(Thousands)		(Per cent)	
Managerial, administrative, and related				
Managers and administrators	29.6	32.0	8.1	8.7
Occupations related to management and administration	18.1	17.5	10.0	9.6
Professionals				
Physical sciences	−0.5	2.4	−2.0	9.4
Life sciences	−0.1	1.0	−1.2	9.1
Architects and engineers	−2.6	10.8	−2.4	9.8
Other occupations in architecture and engineering	108.0	0.0	114.0	0.0
Mathematics, statistics, systems analysis, and related	−65.4	9.0	−177.7	24.6
Social sciences	−0.1	1.1	−0.8	10.3
Social work and related fields	−0.2	1.8	−1.2	12.3
Law and jurisprudence	0.0	4.5	0.1	12.6
Library, museum and archives, religion and other occupations in social sciences and related fields	0.0	0.6	−0.5	10.6
University teaching and related occupations	0.0	0.4	−0.5	10.4
Elementary and secondary school teaching and related occupations	−0.1	2.9	−0.5	10.4
Other teaching and related occupations	−0.2	2.2	−1.1	10.4
Health diagnosing and treating occupations	−0.1	0.7	−0.8	8.7
Nursing, therapy and related assisting occupations	−0.4	3.6	−1.1	10.4
Other occupations in medicine and health	−0.8	3.3	−2.5	10.0
Fine and commercial art, photography, and related	−1.0	5.5	−1.9	10.7
Performing and audiovisual arts	0.3	2.1	1.2	7.4
Occupations in writing	0.4	2.0	1.7	7.7
Sports and recreation	−0.6	2.2	−3.4	11.8
Clerical				
Stenographers and typists	43.4	26.2	15.1	9.1
Bookkeeping, account-recording, and related	83.9	57.7	13.6	9.4
Office machine and electronic data-processing-equipment operators	13.4	5.1	20.7	7.8
Material recording, scheduling, and distributing	37.0	15.3	17.9	7.4
Library, file and correspondence clerks, and related	4.4	1.6	23.3	8.2
Reception, information, mail, and message distribution	21.3	8.5	12.9	5.2
Other clerical and related	12.1	17.8	6.1	9.0
Sales				
Sales occupations, commodities	25.7	89.6	2.8	9.9
Sales occupations, services	14.5	15.1	10.1	10.6
Other sales occupations	1.3	2.9	4.2	9.4
Service				
Protective service occupations	−0.8	6.7	−1.3	11.5
Food and beverage preparation and related services	−11.4	52.4	−3.0	13.9
Occupations in lodging and other accommodation	−1.6	8.7	−2.6	13.9
Personal service	−7.4	14.2	−7.2	13.9
Apparel and furnishings service	−2.5	4.8	−7.0	13.4
Other service	−9.4	26.6	−4.4	12.4

Table 4-11 (cont'd.)

	Displacement	Re-employment	Proportion of employment in 1981	
			Displacement	Re-employment
	(Thousands)		(Per cent)	
Primary occupations				
Farmers	−2.3	14.2	−0.9	5.9
Farm management	−0.4	2.2	−0.9	5.9
Other farming, horticultural, and animal husbandry	−2.7	14.9	−1.2	6.6
Fishing, hunting, trapping and related	−1.1	4.4	−2.8	11.6
Forestry and logging	−1.0	3.7	−1.8	7.0
Mining and quarrying, including oil and gas field	−1.1	4.8	−1.8	7.9
Processing occupations				
Mineral ore treating	0.4	0.5	5.5	7.1
Metal processing and related	1.0	5.4	1.5	8.0
Clay, glass, and stone processing, forming, and related	1.0	1.2	6.2	7.2
Chemicals, petroleum, rubber, plastic, and related material processing	3.8	3.1	9.5	7.8
Food, beverage, and related processing	12.3	10.5	8.4	7.1
Wood processing, except paper pulp	2.5	2.8	6.0	6.9
Pulp and papermaking, and related	2.8	2.8	6.6	6.6
Textile processing	1.7	1.1	4.6	3.0
Other processing	0.4	0.3	5.8	4.8
Machining and related occupations				
Metal machining	73.3	0.3	89.0	0.3
Metal shaping and forming, except machining	151.5	0.6	98.1	0.4
Wood machining	9.9	0.0	83.4	0.4
Clay, glass, stone, and related material machining	8.1	0.1	91.7	0.2
Other machining and related	14.7	0.1	96.5	0.4
Product fabricating, assembling, and repairing				
Fabricating, assembling: metal products, n.e.c.	0.0	7.4	0.0	8.7
Fabricating, assembling, installing, and repairing: electrical, electronic, and related equipment	8.5	7.4	7.6	6.6
Fabricating, assembling, and repairing: wood products	2.0	2.7	5.6	7.5
Fabricating, assembling, and repairing: textile, fur, and leather products	9.7	8.6	6.1	5.4
Fabricating, assembling, and repairing: rubber, plastic, and related products	3.6	4.9	10.3	14.4
Mechanics and repairmen, n.e.c.	30.0	27.1	9.6	8.6
Other product fabricating, assembling, and repairing	4.1	5.9	5.6	8.0
Construction trades and transport equipment operators				
Excavating, grading, paving, and related occupations	−2.2	8.9	−2.4	9.7
Electrical power, lighting, and wire communications equipment: erecting, installing, and repairing	0.0	8.3	0.0	7.2
Other construction trades occupations	−13.7	45.3	−3.1	10.2
Air transport operating	−0.3	1.2	−2.0	8.9
Railway transport operating	−0.5	2.5	−2.0	8.7
Water transport operating	−0.3	1.2	−2.1	9.0
Motor transport equipment operating	−7.1	29.2	−2.2	9.2
Material handling, equipment operators and crafts				
Material handling and related occupations, n.e.c.	17.3	16.0	8.3	7.7
Printing and related	4.7	3.0	8.4	5.2
Stationary engine and utilities equipment operating	3.4	2.7	9.7	7.9
Electronic and related communications equipment, n.e.c.	0.8	0.3	9.9	3.5

Table 4-11 (concl'd.)

	Displacement	Re-employment	Proportion of employment in 1981	
			Displacement	Re-employment
	(Thousands)		(Per cent)	
Other crafts and equipment operating occupations, n.e.c.	1.0	1.0	10.7	11.1
Total	644.0	715.4	7.9	8.8

1 Displacement is the difference between scenarios A and B of Table 4-10; and re-employment is the difference between scenarios C and B.
SOURCE Based on simulation results of MESIM.

disappear. All re-employment opportunities are for only those workers capable of working with the new technology in the industries directly affected by the new technology.

Other Uses of MESIM: The Importance of Education

It is clear, then, that the MESIM model can provide some helpful insights concerning the direction and magnitude of the impact of computer-based technological change across industries and occupations. Thus MESIM provides us with an estimate of the size and nature of the adjustment task that the labour market must perform. MESIM can also serve as the basis for a number of related analyses. For example, it allows us to examine the prospects for female employment, in Chapter 9. And, in this section, we build upon the detailed occupational results of MESIM by using 1981 census statistics to show the education content of the occupations in question. Data on the education requirements of jobs – expressed in terms of elementary, high school, or university – then give us further information about the nature of the adjustment process.

In the following analysis we assume that the distribution of such education requirements across occupations remains unchanged over the period 1981-95. Then, using the results from the previous Table 4-11 we can estimate the education content of *three* types of occupational employment change. The first type involves the direct labour displacements – namely, all the *positive* valued displacements in column 1 of Table 4-11. The total labour displacement by this measure (which avoids arithmetic cancellations) equals about 780,000 workers. The second type involves the direct and indirect labour creation following CBTC (without re-employment) – namely, all the *negative* valued displacements in column 1 of Table 4-11. The total labour creation by this measure equals about 135,000 workers. Finally, the third type of occupational change involves the labour re-employment opportunities following CBTC – namely, all the re-employment figures in column 2 of Table 4-11. The total of this column equals about 715,000 workers.

Table 4-12 shows the education content of the various occupations affected by each of the three types of occupational change. The education content of the occupations affected by (direct) labour displacement is very similar to the education content of the occupations affected by labour re-employment. There is, however, a significant difference when we analyse the category called "labour creation"; here, university education is relatively more important. But labour creation, as defined, only adds about 135,000 employed over the period 1981-95, according to MESIM, in contrast to the much larger number potentially unemployed (or directly displaced) and potentially re-employed for the other two categories of labour. This three-way classification exercise serves, then, to focus our attention on where higher education may, or may not, play a significant role as a complement to future Canadian technological change.

Table 4-12

Education Content of Labour Affected by Technological Change, Canada, 1981-95

	Distribution, by educational level		
	Elementary school	High school	University
		(Per cent)	
Effect on labour:			
Labour displacement	10.1	74.9	14.9
Labour creation	11.5	52.5	35.9
Labour re-employment	13.8	68.7	17.5

SOURCE Based on simulation results of MESIM.

We emphasize that the exercise is limited by our assumption that the education content of occupations will remain about the same over the period 1981-95. Nevertheless, the exercise illustrates how one may build upon MESIM results to gain further insights into certain qualitative aspects of labour market adjustments to technological change.

Conclusion

The MESIM model is not meant to be used to project employment levels, but rather to compare employment effects under different assumptions which can affect the potential rates of displacement and re-employment. Observation of the *patterns* of labour displacement and re-employment, both by industry and by occupation, provide some insight into the severity of the labour-mismatch problem following CBTC and illustrate the extent of the need for labour-adjustment policies.

It should also be noted that MESIM is capable of yielding a wide variety of scenario results, some of which focus on other future aspects of the Canadian economy. For example, our scenario B (CBTC labour displacement without re-employment) results in an increase in the total Canadian unemployment rate of about 4 percentage points when compared with the reference scenario A (extrapolation without CBTC). This result is sensitive to the assumptions with respect to labour supply, the rate of CBTC diffusion, the number of "hours worked per week," and the structure of Canadian international trade. In any event, essentially the same *patterns* of potential labour displacement and potential labour re-employment emerge, both by industry and by occupation.

Finally, we end with a note of caution concerning the interpretation of the MESIM model. Most importantly, we have so far assumed that in order to move the Canadian economy from scenario B (displacement without re-employment) to scenario C (displacement with re-employment) the classical market mechanism must work perfectly. That mechanism is generally described as follows: technological change (specifically, CBTC) causes productivity increases that lead to higher real incomes, higher real (final) demand and, therefore, re-employment of the labour initially displaced by the technological change. Judging from historical experience, one might expect such a mechanism to work out in the long run. In the shorter run, however, there might well be important differences between theory and practice. It is clear, for example, that the high rate of CBTC diffusion in scenario B, representing an upper bound on labour displacement, imposes a very heavy burden on the adjustment mechanism. We know, too, that, in the real world, adjustment to change is not always accomplished easily and smoothly. It depends critically upon the attitudes, perceptions, and actions of thousands of individuals and firms. Thus, as we point out in later chapters, technological change can be uneven and disruptive: it has the potential to create both winners and losers. It is for these reasons that we place a good deal of emphasis in the remainder of this report on policies and programs that can facilitate the process of adjustment.

5 In Search of the Declining Middle

In Chapter 2 we examined sources of change in the distribution of occupational employment and considered the influence of technological change on those shifts. In this chapter, we are concerned also with the distributional impacts of technological change but, this time, on skills and income. It has been suggested that one effect of rapid advances in technology has been a distribution of income that is skewed to the upper and lower classes, leaving relatively fewer workers with incomes in the middle. Other factors, such as changes in the industrial and demographic structure, have also been said to be shrinking the middle class. The major purpose of this chapter is to examine the "declining middle" in Canada.

Why are people worried about a shrinking middle class? First of all, there is concern that without mid-level opportunities, workers seeking advancement will be locked into, and frustrated by, low-wage jobs. Besides, the middle class has been an important source of consumer demand and thus of growth in income and employment; hence the possible erosion of that middle-class market would have important implications, not only for the structure of production but also for economic development in general. Finally, in addition to economic considerations, the middle class has traditionally been a major source of social and political stability.

The chapter begins by outlining the suggested causes of the declining middle and proceeds with a description of available Canadian evidence. Then we outline our own approach to the issue, including a discussion of the methodology used and the results obtained. The approach incorporates an analysis of the impact of not only technological change but other factors – and not just on the middle class but on the distribution of income in general. Finally, we summarize our findings, present a view of the future, and provide some possible policy implications.

The Debate

The concept of a declining middle class was popularized by Robert Kuttner in 1983, when he predicted that trends in the U.S. economy were leading to a distribution of skills and incomes skewed to the upper and lower extremes. Technological change played a central role in this "declining middle" hypothesis, along with the decline of unions and a regressive fiscal policy.[1] Kuttner's thesis touched off a debate that widened to include not just employment income but also other factors, such as the changing demographic and family structure.[2] Indeed, such trends are influencing the overall distribution of income.[3] Our research focuses on employment income, however, since it is more sensitive to the kinds of changes that we are considering in this report.

Factors that are considered to underlie shifts in the distribution of employment income include:

- *Occupational shifts* — The principal way in which technological change affects the distribution of employment income is through changes in the occupational structure. While automation has eliminated many low-skilled, mundane, and dangerous jobs, it has also had deskilling effects on others. At the same time, the introduction of new technologies has placed a premium on highly paid specialists like engineers and scientists. Some observers maintain, however, that the distributional impacts of high-tech industries on incomes and occupations is no more skewed than for the rest of the economy.[4]

- *Changes in industrial structure* — The ongoing shift of employment in the postwar period from the manufacturing sector to the service sector has also had implications for the distribution of income. Earlier in this report, we documented the growth of service-industry jobs and the simultaneous decline of manufacturing employment in recent decades. This "deindustrialization" is integral to the income-polarization thesis, which sees middle-income jobs as less typical of service-sector than manufacturing employment.

- *Increasing part-time employment* — Part-time workers, most of them earning less than full-timers, are increasing in number. This implies an expansion of the lower class at the expense of middle-income earners.

- *Rising female and youth participation* — Throughout the 1970s, the "baby boomers" and females entering the labour market tended, because of lack of skills and experience, to take part-time, high-turnover, low-paying jobs, thus swelling the numbers of people with lower incomes. As these workers mature and gain experience, however, their incomes should rise,

thus restoring the depleted ranks of the middle class. But, by the same token, it is pointed out that there is no reason to believe that the large cohort of "baby boomers" that is now depressing the average wage level will not continue to do so as they move along their career paths.

• *Education* — One of the fundamental determinants of employment income is educational attainment; therefore, as educational levels change, we would expect the income distribution to be affected.

All of the factors we have discussed are explicitly included in our analysis. In passing, however, it should be pointed out that we are aware that a number of other variables, not expressly considered, also affect the distribution of employment income. Most notable is the business cycle.

Canadian Evidence to Date

In Canada, the "declining middle" debate has sparked much interest. In some related work, Michael Wolfson focused on the fact that despite major social changes, such as increasing family breakdowns and high youth and female labour-force participation, as well as large swings in the economy, the distribution of family incomes remained fairly stable between 1965 and 1983.[5] While demographic shifts had indeed been increasing family-income inequality, macroeconomic changes had offset those disequalizing effects.[6]

In another research effort, Lars Osberg focused on the impact of technology-induced occupational shifts on the distribution of employment income.[7] He assigned occupations to four groups according to their potential for productivity growth and labour displacement from technological change. While these groups were characterized by varying degrees of income disparity (Table 5-1), Osberg argued that occupational shifts in employment would, nevertheless, lead to a stable overall distribution of income. Although employment shifts from the goods to the personal service occupations contribute to income inequality, this would be counterbalanced by the coincident shifting emphasis within the information sector from data-based to more knowledge-based occupations.[8]

Using available census data, we have also looked at the "declining middle" phenomenon. One of our early efforts involved an examination of the contribution of the high-tech sector to middle-class job growth.[9] The analysis was based on the annual employment income of full-time/full-year individuals; the middle class was defined as those workers whose incomes were within 15 per cent – above or below – the mean income; and

Table 5-1

Individual Employment-Income Inequality Indicators within Techno-Occupational Groups,[1] Canada, 1981

	Middle 3 quintiles' income share	Gini coefficient
	(Per cent)	
Goods[2]	58.9	0.304
Personal services[3]	52.7	0.419
Knowledge[4]	58.0	0.310
Data[5]	53.9	0.362
All occupations	55.6	0.355

1 Techno-occupational structure is based on the degree to which workers are deemed replaceable by machines – *i.e.*, there is potential for productivity increases.
2 "Goods" occupations include farming, mining, processing, machining, fabricating, repairing, construction trades, and transport equipment operators.
3 "Personal services" include some occupations in medicine and health, and other service occupations like cleaners, fire fighters, police officers, food servers, and guards.
4 "Knowledge" occupations represent occupations in management, physical sciences, social sciences, teaching, and the arts and literature.
5 "Data" occupations include managerial, teaching, clerical, and sales occupations, and some occupations in medicine and health.
Source: Lars Osberg, "Paying information workers," draft Chapter 3 of *The Information Sector: Unbalanced Growth and Its Implications*, ed. Lars Osberg *et al.*, Institute for Research on Public Policy (forthcoming).

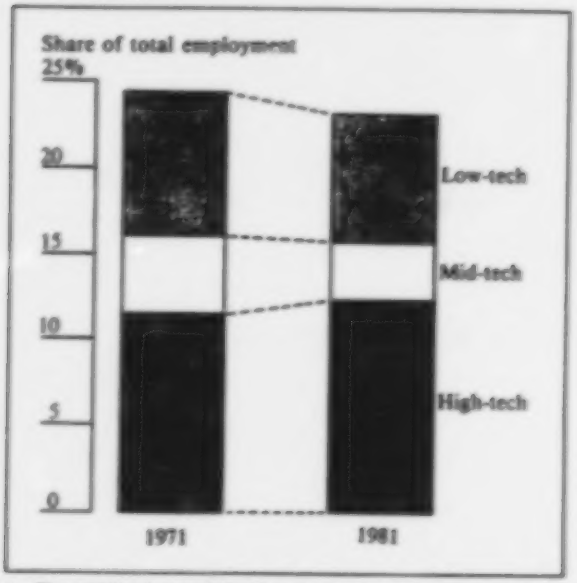
the high-tech sector was defined as in Chapter 2 – that is, on the basis of industries' use of high-tech inputs for production. We found that although there had been some erosion in the middle-class share of total full-time/full-year employment from 1971 to 1981, the high-tech sector's share of total middle-class employment actually rose (Chart 5-1). On the other hand, the mid- and low-tech sectors saw their share of middle-class employment fall.

Though this analysis yielded some interesting results, it should be emphasized that it ended in 1981, the most recent year for which industry census data were available. Moreover, data shortcomings limited the analysis to full-time/full-year incomes, thereby excluding the growing part-time element, which may have a negative impact on income equality.

We also examined the quality of the emerging employment structure; as we noted, one of the fears about technological change is that it is polarizing not only incomes but also skills.[10] To assess this claim we looked at the relative employment income and a skill proxy – educational qualifications – of the fastest-growing and fastest-

Chart 5-1

Distribution of Middle-Class[1] Employment of Full-Time/Full-Year Individuals, by Technological Sector,[2] Canada, 1971 and 1981



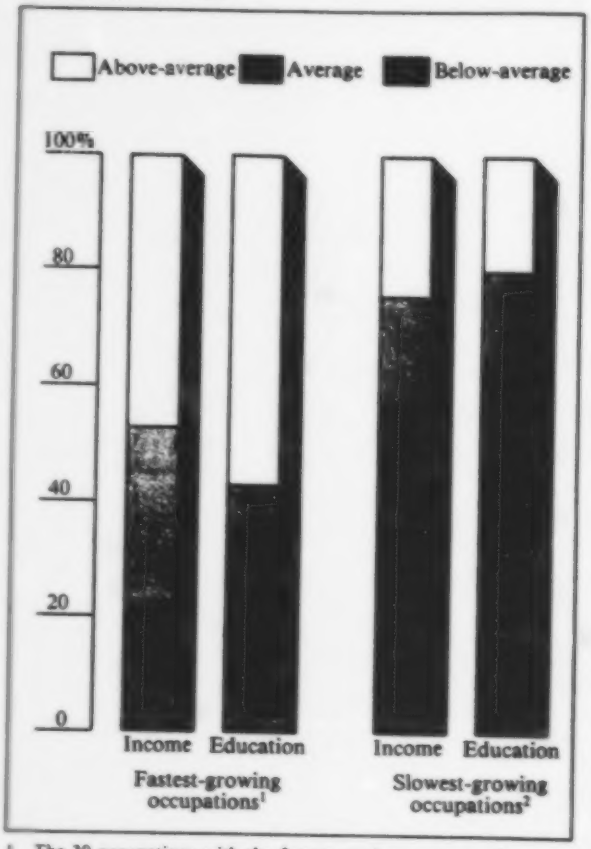
1 The middle class is defined as the band of incomes that falls within 15 per cent (plus or minus) of national-average employment income.

2 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top-ranking one-third were considered to be high-tech; the middle one-third, mid-tech; and the lowest one-third, low-tech. For more details, see Chapter 2 of this report.

SOURCE Based on Tom Siedule, "Notes on the declining middle," Economic Council of Canada, March 18, 1986, mimeo.

Chart 5-2

Income and Education Shares of Fastest- and Slowest-Growing Occupations, Canada, 1971-81



1 The 30 occupations with the fastest employment growth, 1971-81.

2 The 30 occupations with the slowest employment growth, 1971-81.

SOURCE Based on Keith Newton and Norm Leckie, "The employment effects of technological change," *New Technology, Work and Employment*, Autumn 1987, forthcoming.

declining occupations.[11] If skill polarization were occurring, then we might expect the fastest-growing occupations to show a polarized skill structure and the fastest-declining ones to be generally middle-class. In fact, the fastest-growing jobs between 1971 and 1981 were generally of a more highly qualified nature than those in swiftest decline, which were generally below average in relative income and educational requirements (Chart 5-2). Nor did the preliminary findings of research carried out at Statistics Canada, based on detailed occupational census data, produce any clear-cut evidence of skill polarization.[12]

A New Approach

To investigate the "declining middle" debate in Canada more fully, we arranged with Statistics Canada for the development of a micro data set and flexible software package that, together, are capable of empirically evaluating the impact of a number of variables on the distribution of income over the 1971-83 period.[13] In this section we outline the data and the measures used to examine the question, as well as the results of the analysis.

The data set is based on Statistics Canada's Survey of Consumer Finances (SCF) and is composed of records containing income information on large samples

of census families and unattached individuals for selected years in the 1971-83 period.[14] This family file was converted to one based on the individual – the subject of our present investigation.[15] The income elements covered include employment, investment, transfer, disposable, and total income, though we are primarily concerned with employment income since it should be more sensitive to labour market forces than other income elements.

The Measures

To investigate the declining middle, we developed a number of complementary measures. First, changes in the mean level of income were identified. Since the mean cannot capture *distributional* trends, however, a second step was taken. Here, we defined the share of income going to middle-income earners in two ways – as the middle one-third and as the middle 60 per cent of earners, ranked by their employment incomes. An alternative way of defining the middle class formed our third approach, which focuses on identifying the changing size of the middle class. This was done by defining income classes on the basis of the distance of earners' incomes from the mean. In this case, the middle class of incomes was defined as that band of incomes that fall within 25 per cent above or below the mean income.

In addition to indicators of middle-class erosion, we are also concerned with the wider issue of income inequality. The traditional measure of income inequality is the Gini coefficient, which gauges the extent to which complete inequality has been reached: the higher its value, the less the equality of the income distribution. A separate, though related, issue is that of polarization, for it is possible to have an equitable income distribution that is at the same time skewed to the upper and lower classes. To measure polarization, we used W-Pol, an indicator based on the extent to which the population tends to cluster at two discrete points along the income spectrum.[16] The higher its value, the greater the polarization; when it has a value of one, the distribution is not only completely polarized but completely inequitable.

Is There a Declining Middle?

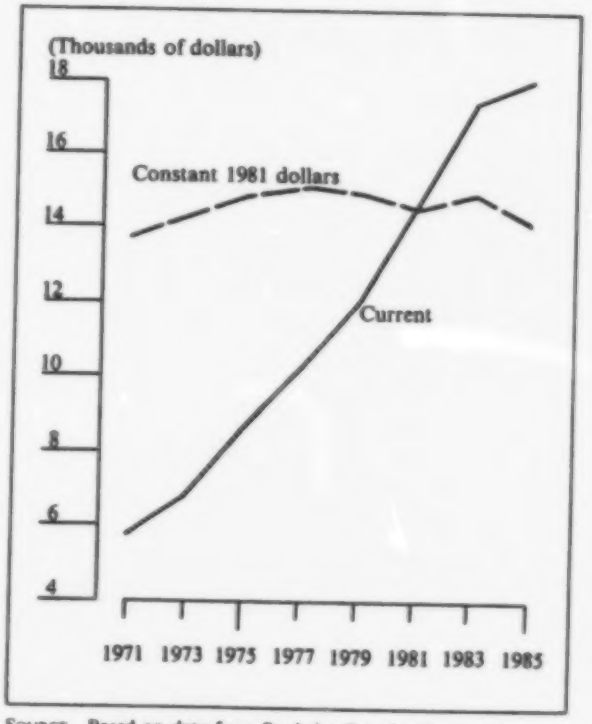
Two main questions form the focus of our analysis. First, have there been major shifts in factors associated with technological change, such as the occupational and industrial structure? Second, *has* there been a middle-class decline in Canada overall and in particular groups defined by age, sex, education, occupation, and industry?

In every year since 1971, the average earnings of all workers, measured in current dollars, have risen (Chart 5-3). When measured against the price index, however, average earnings have actually fallen since 1977 – an indication that, overall, workers in Canada are losing ground. Nevertheless, the *distribution* of total income, including income from employment, investment, transfers, and so on, has remained rather stable (Chart 5-4). The middle-class share has remained at just under 50 per cent of total income and the upper-class share, at just slightly less than the middle-class share; the lower-class share has hovered around the 2 per cent mark. In other words, it does not appear that the middle-class share of total income has been decreasing.

Next, we turn to an examination of employment income. Table 5-2 shows employment-income shares and means by sex, age, and education. Between 1971 and 1983, the gap between the work-force[17] and the income shares of males and females, though still large, narrowed. Furthermore, the relative size of the gains

Chart 5-3

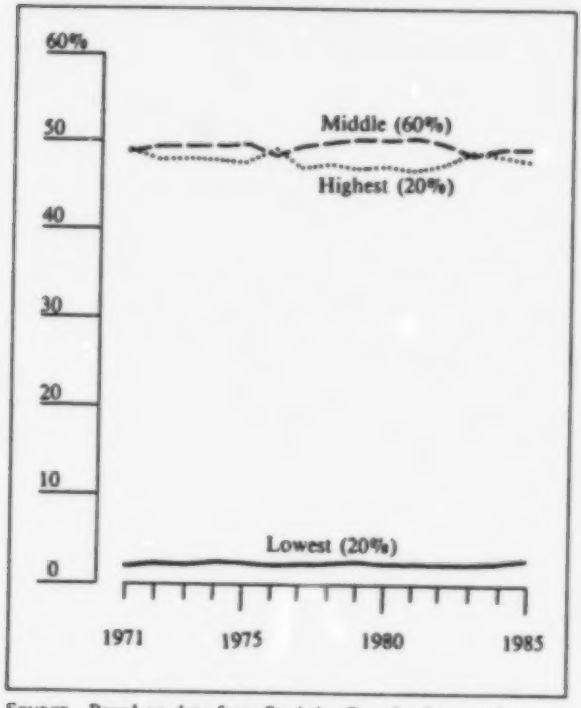
Average Level of Earnings of Workers, Canada, 1971-85



SOURCE Based on data from Statistics Canada, Survey of Consumer Finances.

Chart 5-4

Total Income Quintile Shares for Individuals, Canada, 1971-85



SOURCE Based on data from Statistics Canada, Survey of Consumer Finances.

made by women over the period was larger than that by men. The mean income of women increased relative to the national average, while that of men showed little change, remaining at roughly 120 per cent.

Turning to the age dimension, it can be seen that between 1971 and 1983 the two extremes diminished in significance, while the prime-age (25-to-44-year-old) "baby boomer" workers' share of the work force grew and that of the 45-to-64 age group remained fairly constant. The income shares of each age group displayed a similar pattern. On the other hand, the mean employment income of the prime-aged fell against the national average, while those aged 45 to 64 years gained.

Looking at the educational patterns, we observe some of the changes that took place between 1971 and 1983. The work-force and income shares of those with no more than elementary education fell, while those with a college certificate or university degree increased. Those with no more than secondary school education maintained their share of the work force at just under one-half. If we look at mean incomes, however, we see that, relative to the national average, each educational group experienced a decrease at some point and that those with a university education experienced the greatest losses.

With regard to employment status,[18] the proportion of persons working full-time/full-year remained constant at about two-thirds throughout the period (Table 5-3).[19] Relative to the national-average employment income, a person working less than full-time/full-year lost some ground, while full-timers gained.

On the occupational dimension, we find that professionals/managers increased both their work-force and their income shares. Clerical/sales workers, on the other hand, maintained a stable share of the work force over the period but saw their share of employment income decrease. And blue-collar workers experienced decreases in both work-force and income shares – a reflection of shifts in the industrial structure. Also, the gap in mean incomes among occupations relative to the national average widened, though the ranking remained the same – managers/professionals, followed by blue-collar workers, and, lowest of all, sales and clerical occupations.

Finally, there were some shifts in the industrial distribution of the work force: the service sector showed significant gains while the secondary sector lost ground. Similarly, the income share of services increased while that of the secondary sector decreased. In terms of mean income relative to the national average, the primary, services, and trade sectors each lost some ground.

These observations point to the fact that between 1975 and 1983, shifts did indeed take place in the distribution of income across the sexes, age groups, educational levels, occupations, and industries. The question that remains is: are income shifts taking place within these groups that may contribute to a change in the size of the middle class?

Tables 5-4 and 5-5 show a number of indicators of inequality. For the work force as a whole, the trend indicates that there has been some shift in the distribution of income, though the evidence is, on balance, inconclusive. The income share of the middle class, defined as the middle one-third of the work force ranked on their incomes, has remained more or less constant. The proportion of workers with middle-class incomes declined, however, from 30 per cent in 1971 to 26 per cent in 1983 (Table 5-4). And the two other measures – the Gini coefficient and W-Pol – indicate a slight increase in inequality and polarization.

Table 5-2

Distribution of Work Force and Employment Income, and Relative Mean Employment Income, by Sex, Age Group, and Education Level of ELFP[1] Individuals, Canada, 1971, 1979, and 1983

	Distribution of:								
	Work force			Employment income			Mean employment income relative to national mean		
	1971	1979	1983	1971	1979	1983	1971	1979	1983
					(Per cent)				
All groups:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
By sex									
Males	66.9	60.2	58.3	80.7	74.5	71.7	120.6	123.8	123.0
Females	33.1	39.8	41.7	19.3	25.5	28.3	58.3	64.0	67.8
By age group (years)									
Under 25	14.6	14.0	10.9	9.1	9.3	6.1	62.5	66.0	56.4
25 - 44	49.2	53.9	56.3	53.6	57.3	58.8	109.1	106.3	104.4
45 - 64	32.6	29.2	30.1	35.1	32.0	33.5	107.7	109.7	111.2
65 and over	3.6	2.9	2.7	2.1	1.4	1.6	58.8	50.6	58.8
By education level									
None or elementary	25.9	18.0	14.7	20.9	15.6	11.6	80.4	87.0	78.8
Some/all secondary	49.6	50.2	47.2	46.7	46.4	41.7	94.1	92.4	88.3
Some postsecondary	7.3	8.1	9.2	7.8	8.0	9.0	107.1	98.0	98.1
College certificate	9.2	12.1	14.2	10.0	12.5	15.1	109.0	103.1	106.5
University degree	7.9	11.6	14.7	14.6	17.5	22.6	184.1	151.0	153.8

1 ELFP - effective labour force participant - one who earns at least 2.5 per cent of the average industrial wage. Proportions here may not represent proportions in the population at large.

Source Based on data from Statistics Canada, Survey of Consumer Finances; and calculations by the Social and Economic Studies Division of Statistics Canada and by the Economic Council of Canada.

Table 5-3

Distribution of Work Force and Employment Income, and Relative Mean Employment Income, by Employment Status and by Occupational and Industrial Groups of ELFP[1] Individuals, Canada, 1975, 1979, and 1983

	Distribution[2] of:						Mean employment income relative to national mean		
	Work force			Employment income					
	1975	1979	1983	1975	1979	1983	1975	1979	1983
	(Per cent)								
All groups:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
By employment status									
Full-time/full-year	65.7	68.0	65.2	82.1	83.4	83.3	125.1	122.6	127.8
Less than full-time/full-year[3]	32.9	30.1	33.9	17.5	16.0	16.5	53.2	53.3	48.7
By occupational group									
Professional/managerial	24.5	23.8	29.1	32.4	31.0	39.8	132.0	130.2	136.6
Clerical/sales	41.4	42.6	41.4	32.9	33.9	30.7	79.4	79.6	74.3
Blue-collar[4]	32.8	32.5	28.8	34.3	34.8	29.2	104.6	107.1	101.4
By industrial group									
Primary[5]	6.3	6.5	6.7	6.3	6.2	6.1	100.2	96.4	89.7
Secondary[6]	36.9	35.9	33.2	40.4	39.9	36.8	109.5	111.1	111.1
Trade	14.5	15.1	15.1	12.8	13.5	12.5	88.2	89.4	82.9
Services[7]	16.1	19.2	20.1	13.8	16.6	16.9	85.9	86.4	84.4
Public administration	24.9	22.2	24.2	26.2	23.4	27.4	105.1	105.6	113.2

1 ELFP - effective labour force participant - one who earns at least 2.5 per cent of the average industrial wage. Proportions here may not represent proportions in the population at large.
2 Because of reporting errors at the household level, distributions will not add up to 100.
3 Includes those working full-time but only for part of the year; so, this category does not coincide with the Labour Force Survey definition of part-time.
4 Includes farming, mining, processing, machining, assembling, repairing, construction trades, and transport equipment operating.
5 Includes agriculture, fishing, forestry, and mining.
6 Includes manufacturing and construction.
7 Includes finance, insurance, and real estate; communications; transportation; public services (e.g., hospital, school); and commercial services (such as business, restaurant, hotel, and so on).

SOURCE Based on data from Statistics Canada, Survey of Consumer Finances; and calculations by the Social and Economic Studies Division of Statistics Canada and by the Economic Council of Canada.

Table 5-4

Employment-Income Inequality Indicators by Sex, Age, and Education Level of ELFP[1] Individuals, Canada, 1971, 1979, and 1983

	Work-force share with middle-class income[2]			Income share of middle tertile[3]			Gini coefficient[4]			W-Pol[5]		
	1971	1979	1983	1971	1979	1983	1971	1979	1983	1971	1979	1983
	(Per cent)											
All groups:	30.0	28.1	26.0	27.7	30.3	29.3	0.393	0.381	0.405	0.699	0.710	0.713
By sex												
Males	39.0	38.6	32.9	30.6	31.7	30.9	0.343	0.324	0.359	0.679	0.690	0.697
Females	26.7	26.9	24.2	30.1	30.5	29.1	0.403	0.390	0.413	0.715	0.719	0.724
By age group (years)												
Under 25	28.8	28.5	21.2	31.8	30.6	29.1	0.365	0.377	0.413	0.716	0.719	0.734
25 - 44	33.0	31.0	28.5	31.0	31.0	30.2	0.364	0.358	0.381	0.692	0.706	0.709
45 - 64	30.7	30.2	28.1	29.2	30.4	29.4	0.394	0.373	0.398	0.694	0.704	0.708
65 and over	20.4	16.8	16.4	24.9	22.6	20.9	0.522	0.533	0.551	0.711	0.740	0.741
By education level												
None or elementary	28.3	27.6	24.4	31.0	30.6	29.4	0.371	0.383	0.401	0.714	0.714	0.725
Some/all secondary	29.3	29.1	27.0	30.8	30.9	29.9	0.370	0.367	0.395	0.708	0.713	0.714
Some postsecondary	29.6	27.1	25.9	30.6	30.3	30.0	0.398	0.393	0.405	0.703	0.711	0.711
College certificate	35.3	30.3	30.0	31.1	31.7	31.0	0.350	0.352	0.370	0.692	0.710	0.705
University degree	33.1	32.4	34.9	27.8	31.3	31.7	0.407	0.359	0.359	0.687	0.702	0.692

1 ELFP - effective labour force participant - one who earns at least 2.5 per cent of the average industrial wage.
2 Middle class here comprises individuals whose income is within 25 per cent of the mean, either way.
3 Middle tertile is the middle third of individuals, ranked by their employment income.
4 A measure of income inequality; the greater the value, the greater the inequality.
5 A measure of the degree to which income is concentrated near the tails of the distribution; the greater its value, the greater the polarization.

SOURCE Based on data from Statistics Canada, Survey of Consumer Finances; and calculations by the Social and Economic Studies Division of Statistics Canada, and by the Economic Council of Canada.

Table 5-5

Employment-Income Inequality Indicators by Employment Status and by Occupational and Industrial Groups of ELFP[1] Individuals, Canada, 1975, 1979, and 1983

	Work-force share with middle-class income[2]			Income share of middle tertile[3]			Gini coefficient[4]			W-Pol[5]		
	1975	1979	1983	1975	1979	1983	1975	1979	1983	1975	1979	1983
	(Per cent)											
All groups:	29.7	28.1	26.0	29.7	30.3	29.3	0.389	0.381	0.405	0.701	0.710	0.713
By employment status												
Full-time/full-year	39.9	40.0	37.8	29.8	30.7	30.2	0.300	0.292	0.309	0.693	0.697	0.695
Less than full-time/full-year[6]	22.1	20.5	20.0	25.8	24.8	25.3	0.448	0.463	0.457	0.726	0.730	0.728
By occupational group												
Professional/managerial	34.4	32.8	34.6	29.8	30.8	30.9	0.368	0.352	0.357	0.690	0.700	0.696
Clerical/sales	29.7	28.2	25.9	28.7	29.5	28.6	0.417	0.404	0.429	0.698	0.707	0.714
Blue-collar[7]	35.8	34.1	29.8	32.1	32.5	31.9	0.314	0.316	0.345	0.701	0.707	0.715
By industrial group												
Primary[8]	23.9	22.4	18.5	27.2	28.4	25.5	0.470	0.432	0.505	0.706	0.721	0.722
Secondary[9]	36.5	35.7	32.1	31.4	32.1	31.1	0.322	0.319	0.351	0.696	0.703	0.702
Trade	28.2	27.2	25.6	28.6	29.2	29.0	0.408	0.396	0.401	0.703	0.712	0.716
Services[10]	25.6	26.0	22.8	25.2	27.3	25.3	0.474	0.445	0.481	0.709	0.709	0.717
Public administration	32.1	30.3	31.0	29.8	30.1	30.9	0.371	0.368	0.361	0.697	0.709	0.711

1 ELFP - effective labour force participant - one who earns at least 2.5 per cent of the average industrial wage.
2 Middle class here comprises individuals whose income is within 25 per cent of the mean, either way.
3 Middle tertile is the middle third of individuals, ranked by their employment income.
4 A measure of income inequality; the greater the value, the greater the inequality.
5 A measure of the degree to which income is concentrated near the tails of the distribution; the greater its value, the greater the polarization.
6 Includes those working full-time but only for part of the year; so, this category does not coincide with the Labour Force Survey definition of part-time.
7 Includes farming, mining, processing, machining, assembling, repairing, construction trades, and transport equipment operating.
8 Includes agriculture, fishing, forestry, and mining.
9 Includes manufacturing and construction.
10 Includes finance, insurance, and real estate; communications; transportation; public services (hospital, school); and commercial services (business, restaurant, hotel, and so on).

SOURCE Based on data from Statistics Canada, Survey of Consumer Finances; and calculations by the Social and Economic Studies Division of Statistics Canada and by the Economic Council of Canada.

A comparison of the indicators for males and females for the 1971-83 period shows similar patterns. The income share of middle-class males and females remained fairly stable, at roughly 30 per cent for both. On the other hand, the numbers of both males and females in the middle class declined as a proportion of the total work force: for males, the share fell from 39 per cent in 1971 to 33 per cent in 1983; for females, from 27 per cent to 24 per cent, respectively. Finally, there was a slight tendency for employment income to become more unequal and polarized.

Looking at the indicators by age, we note slightly increasing inequality in all age groups. Every age group appears to have suffered some decline in the size of the middle, whether measured by income share or work-force share. It was the postwar "baby boomers," now aged 25 to 44, however, who, in 1983, exhibited the least inequality according to all indicators. This would appear to run counter to the premise that the sheer numbers of that generation alone would cause a skewing of the income distribution to the lower extremes. Finally, all measures indicate that it is the shrinking segment of the population aged 65 and over and still working that has exhibited the greatest inequality.

The education breakdown of the inequality indicators reveals no drastic changes in the income or work-force shares of the middle class, apart from those with a university degree. Within the latter group, in fact, all inequality indicators except W-Pol point to growing equality in the distribution of employment income. It would seem, then, that the rising number of persons acquiring a university degree may be contributing to a more equitable distribution of income.

Table 5-5 outlines the inequality indicators for a number of non-demographic factors. We note, first, that there appear to be no striking patterns revealed by the employment-status breakdown. Stability in the middle-class income share is also evident on the occupational dimension. While the work-force share of clerical/sales and blue-collar workers in the middle class showed some decrease between 1975 and 1983, the professional/managerial middle-class share was constant. Inequality, as measured by the Gini coefficient, increased only slightly, and the same was true for the polarization measure.

On the industry dimension, the evidence is not clear-cut. While the work-force share with middle-class incomes fell in each industry, the income shares of the middle-income groups showed no great change. The Gini suggests that inequality increased in some industries and decreased in others. The polarization indicator, on the other hand, suggests that polarization increased to some extent in all industries.

On the whole, the analysis yielded somewhat mixed results. On the one hand, the proportion of employment income accounted for by the middle class appears to be increasing. On the other hand, the share of the work force with middle-class income shows slight decline. These results, plus other available evidence, have led us to sound a note of caution. When we look below the surface at structural changes in employment and relative wages (Table 5-6), we find, first, that the largest and fastest-growing sectors – trade and services – are also, on average, among the lowest-paying. Furthermore, they are losing ground relative to the national employment-income average. Two high-earnings sectors (public administration, and transportation/storage/communications/utilities) have recently experienced decreases in their shares of employment. Furthermore, certain high-paying, goods-producing industries have experienced a drop in their share of employment and a decrease in relative earnings.

Concerns are also raised when we examine the occupational composition of industries (Table 5-7). What is revealed, first, is that "white-collarization" of the labour market is particularly apparent in the primary and secondary sectors. Second, in these industries, but especially in the service sector, this growing white-collar trend is associated with growing numbers of higher-qualified managers and professionals.[20] It is questionable whether the workers from the declining blue-collar occupations can fill the higher-skilled jobs that are being created.

Public attention has recently focused upon a number of instances of income declines resulting from structural change. One such example was documented in a 1985 Canadian Steel Trade Conference paper tracking the income performance of steelworkers after adjustment.[21] That study found that of the 33,000 workers who left the industry from 1978 to 1983 (over one-third of the original 1978 steel work force), almost two-thirds found employment elsewhere. The average real income of those who found other work fell, however, by 3.5 per cent. (The income loss for those who did not find another job was over 75 per cent.) Almost half (47 per cent) of the ex-steelworkers who found jobs did so in the service sector, which the study defined as comprising finance, public services, commercial services, business services, personal services, and public administration.

Other examples of adverse income effects of technological change were reported in a study of the experiences of workers involved in the closure of three plants.[22] In each case, the closure resulted from production rationalization related to technological change, including the automation and the development of sophisticated computer linkages. In each case, also, a large proportion of the workers were unable to find

Table 5-6

Changes in Absolute and Relative Employment and Average Hourly Earnings, by Industry, Canada, 1976-85

	Employment			Average hourly earnings[1]		
		Distribution			Relative to national mean	
	Growth, 1976-85	1985	Change, 1976-85	Growth, 1976-85	1985	Change, 1976-85
	(Per cent)		(Percentage points)	(Per cent)		(Percentage points)
Agriculture	3.4	4.3	−0.7	51.1	39.6	−12.6
Forestry, fishing and trapping	13.1	0.9	--	64.6	77.5	−15.6
Mining	31.3	1.7	0.2	105.6	134.8	5.1
Primary sector	**10.3**	**6.9**	**−0.5**	**85.0**	**66.3**	**−4.6**
Manufacturing	3.0	17.5	−2.8	109.9	106.9	6.1
Construction	−8.6	5.2	−1.5	68.7	106.5	−18.4
Secondary sector	**0.4**	**22.7**	**−4.3**	**99.0**	**106.8**	**0.6**
Transportation, storage, communications, and utilities	5.3	7.8	−0.9	122.6	126.5	14.1
Trade	20.8	17.7	0.3	84.8	78.8	−5.6
Finance, insurance, and real estate	24.5	5.6	0.3	123.1	126.2	14.3
Services[2]	39.1	32.3	5.1	89.0	99.2	−4.6
Public administration	18.3	7.1	−0.1	109.1	116.7	6.3
Tertiary sector	**26.1**	**70.4**	**4.8**	**98.7**	**102.0**	**0.4**
Total	**17.8**	**100.0**	-	**97.8**	**100.0**	-

1 Calculated as wages, salaries, and supplementary labour income, plus, in the case of fishing, net income of unincorporated businesses or, in the case of agriculture, accrued net income of farm operators, divided by paid hours in all industries except agriculture and fishing, where the dividend is *total* hours. Military pay is excluded.

2 Community, business, and personal services.

SOURCE Based on data from Statistics Canada.

Table 5-7

Changes in Occupational Composition of Industries, Canada, 1976-85

	White-collar as a proportion of total employment		Managers and professionals as a proportion of all white-collar employment	
	1985	Change, 1976-85	1985	Change, 1976-85
	(Per cent)	(Percentage points)	(Per cent)	(Percentage points)
Agriculture	6.3	4.1	45.5	−8.4
Other primary industries	25.7	6.1	69.9	5.3
Primary sector	**13.6**	**5.6**	**62.8**	**0.2**
Manufacturing	32.5	3.0	52.7	8.1
Construction	20.4	5.7	54.4	3.9
Secondary sector	**29.7**	**3.9**	**53.0**	**7.6**
Transportation, storage, communications, and utilities	42.5	1.7	41.1	8.4
Trade	75.9	1.5	20.4	14.2
Finance, insurance, and real estate	91.0	0.2	33.1	9.2
Services[1]	62.3	0.3	76.2	0.4
Public administration	66.3	0.9	58.6	5.2
Tertiary sector	**66.2**	**1.1**	**51.2**	**8.3**
Total	**54.3**	**4.0**	**51.6**	**8.1**

1 Community, business, and personal services.

SOURCE Based on data from Statistics Canada, Labour Force Survey.

another job. Moreover, the average skill level and wages of the jobs of those who did find other employment were appreciably less than before. Again, therefore, there is evidence that at the individual level the income effects of technological restructuring can be negative.

Conclusion

In this chapter, we set out to gauge the impact of technological and other structural changes on the distribution of income. The motivation for this investigation was the contention that technological and structural changes are polarizing the distribution of employment income and skills. In looking for evidence, we found that very little quantitative analysis had been undertaken in Canada. Our own preliminary efforts pointed to the fact that between 1971 and 1981 the high-tech sector contributed the bulk of middle-income jobs and that the fastest-growing occupations were of a more highly qualified nature than were those in swiftest decline.

A more up-to-date and comprehensive analysis was clearly required. In the course of that investigation, we first looked at the overall distribution of income for individuals and found a high degree of stability: the middle class did not appear to be declining. The fact that the effects of technological change are confounded by other influences, arising in part out of differences resulting from the demographic, industrial, and occupational characteristics of workers suggested, however, that a more exhaustive analysis was required. The results of that analysis presented some evidence of a slight decline in the middle class in Canada, though the results are inconclusive.

While there is, thus far, no *strong* historical evidence of middle-class decline overall, there are enough signs pointing to the possibility of erosion that we feel compelled to sound a note of warning. First, in many respects, we are still only at the early stages of the current wave of technological change. New advances in computing power, the development of new applications, and the progress being made in other technological fields such as biotechnology, laser and sensing technologies, and advanced materials all promise to cause further changes in our working and home lives. Because Canada is lagging behind in the application of many of these technologies, it may be that we are too early in the process for clear signs of middle-class erosion to have appeared.[23]

Second, there are some disquieting signs that, while there has been little change in the size of the middle class overall, a great deal of movement is taking place under the surface. Some traditional industries are getting smaller because other countries are challenging Canada's position as a supplier of natural resources to world markets; others are getting smaller as newly industrializing countries put in place the technologies and expertise necessary for successful international competition; still others are growing but providing low-paid, low-skilled jobs. Indeed, as further evidence revealed, workers in a number of industries are being displaced by such structural change and are suffering a decline in relative earnings. So, while the benefits of economic growth are large and positive overall, in individual cases there are costs involved.

Through time, occupational shifts take place, whether in response to technological change, changes in international trade, economic growth, or economic decline. While it is possible that these shifts will affect the *size* of the middle class, they will undoubtedly change the composition of the middle class. Society as a whole benefits from economic growth as income and employment grow. It is important, therefore, that in formulating public policy, care be taken to provide assistance to those individuals who may be adversely affected. Part of this aid should come in the form of re-equipping workers with the skills required to make the transition to new types of jobs and to handle the new technologies. That is why training and retraining form such a critical part of our recommended policy package, discussed in Chapter 11 of this report.

6 Technological Change at the Firm Level

Technological change is a complex and somewhat elusive concept, and its effects in areas such as employment, skills, and compensation may not be totally apparent from macro-scale analysis. Other, more socially oriented issues, such as the quality of work and industrial relations, are virtually inaccessible through these methodologies. Accordingly, an important element of our research has taken place at what we call the "micro" (or establishment) level. With the two complementary approaches – macro and micro – a more comprehensive picture can be drawn of how technological change is affecting the labour market.

In this chapter we shall focus on the types of computer-based technological changes that Canadian firms are introducing and the impact of those innovations on a wide range of work-related issues: Who are the innovators? What sorts of new technologies are they implementing? How much change is occurring, and how quickly is it taking place? What is behind decisions to innovate, and how is implementation being planned? In what ways is technological change affecting employment and skill levels within innovating firms, and how are the changes in personnel requirements being met?

A principal assumption in our micro research is that technology does not dictate specific employment and organizational effects. Certainly the nature of the technology can set limits on what is socially feasible, but within those limits, innovation design – and hence its consequences – can take many forms. From our case studies of innovating establishments and in reviewing similar cases carried out by others, it has been quite apparent that microelectronic technologies do not inherently determine particular ways of organizing work and designing jobs. An important lesson from our research is that computer-based technological change can be implemented in any number of ways, with a variety of objectives and diverse effects. Since it is of such consequence, the management of innovation takes on great importance; accordingly, it will receive considerable attention here and in later chapters.

While recognizing the significance of considering technological change at the level of the firm, a micro perspective poses problems for carrying out empirical research. In the first place, technological innovation and its organizational implications are very complex and do not represent a particularly "tidy" subject. As one writer put it, "automation takes many forms."[1] It can also have diverse effects, depending on the situation in which innovation takes place and, as we have already emphasized, on the management approach taken. Second, and not unrelated, there have been considerable shortcomings in the kinds of empirical information brought to bear on concerns such as ours. Much of the knowledge that is available comes from various case studies of innovating organizations, mostly outside Canada.[2] Moreover, there appear to have been few attempts to systematically gather standardized data on innovation and its impacts, either in Canada or elsewhere.

The Economic Council has addressed the problem of limited information by carrying out two complementary data-gathering exercises: a series of case studies of technological change in Canadian organizations and an extensive national survey of establishments on their experiences with computer-based innovations. The case studies have allowed us to observe technological change from the "shop floor." By considering the innovation process in some depth in a handful of organizations, we have been able to appreciate the complexity of technological and organizational change. In addition to providing substantial detail, the individual cases have focused on different aspects of innovation. A listing of the Economic Council case studies, with the major technological and organizational features of each, is presented in Figure 6-1.

Unfortunately, case studies alone cannot provide answers to many of the questions raised earlier in this introduction. In effect, a primary objective of our research is to describe technological changes and their employment impacts in Canadian industry. To this end, the Economic Council carried out its Working with Technology Survey (WWTS) in late 1985.[3] Although it should not be interpreted as an inventory of innovation in Canada, the survey is unique in its coverage of this subject. In addition to cataloguing the new computer technologies reported by the participating establishments, the WWTS also gathered information on the employment and organizational changes accompanying the technical advances. In total, the survey collected data for nearly 1,000 Canadian establishments. Respondents represented all regions of the country and all industries, excluding agriculture, fishing, construction, and public administration. The geographical and sectoral characteristics of the sample are shown in Table 6-1.

Figure 6-1

Economic Council of Canada Case Studies

Industry	Province	Technology	Features
Aircraft-engine manufacturing	Nova Scotia	• Computer-integrated manufacturing (CIM)	• Socio-technical planning • Semi-autonomous work groups • Pay-for-knowledge
Automobile-engine manufacturing	Ontario	• Robots • Statistical process control (SPC) • Just-in-time inventory (JIT)	• Training
Computer services	Alberta Ontario	• Computer-assisted learning (CAL) • Artificial intelligence (AI) • Office automation	• High-tech based growth • Futurist innovations
Electrical and electronic assembly	Ontario	• Robots • Statistical process control (SPC) • Just-in-time inventory (JIT)	• Productivity gain-sharing
Federal government	Quebec	• Office automation	• Relocation • Retraining
Federal government	Ontario	• Office automation	• Semi-autonomous work groups • Retraining
Metal-container manufacturing	Ontario	• Office automation	• Union-management committee
Pulp and paper	New Brunswick	• Production automation	• Retraining • Planning
Rehabilitation research	British Columbia	• Various	• Training disabled workers
Various manufacturing	Quebec	• Various	• Sources of failure

Computer-Based Innovation in the 1980s

The Technologies

It is somewhat paradoxical that technological change is a constant; new ways of doing things are being developed every day. What sets the current wave of computer-based technological change apart is the wide applicability of the technology. Today, computers can be used in any number of situations to perform a wide variety of tasks. And with each new generation of computer technology the range of applications is widening. This variety is reflected in the technologies that the survey respondents introduced in the 1980-85 period. Applications ranged from a single personal computer used for sales and marketing analysis to integrated office networks, and from automated sewing machines to welding robots and computer-numerically-controlled (CNC) lathes in the factory.

The first half of the 1980s was a period of substantial change and, particularly, a period of office automation. Close to two-thirds of the technological changes reported by the WWTS respondents consisted of the introduction of word processors, personal computers/workstations, office networks, and other office applications (Chart 6-1). Computers are essentially tools that enable information to be processed quickly and in large quantities. A basic function of any office, regardless of industry, market, or location, is the processing of information. With the advent of the microchip in the 1970s, the versatility of the computer exploded, and the large – and largely untapped – office market became a voracious consumer of this new tool. This was the case in all industries, including manufacturing and the primary industries, as well as in the more obviously information-oriented industries, such as banking and business services.

While office innovations predominated in the early 1980s, Canadian firms were, at the same time, also introducing process technology. Twenty-three per cent of the cases of computer-based technological change consisted of process technologies, primarily computer-

Table 6-1

Working with Technology Survey: Sample Distribution, by Province and by Industry, Canada, 1985

	Distribution (Per cent)	
Province:		
Newfoundland	1.1	
Prince Edward Island	0.6	
Nova Scotia	2.6	
New Brunswick	1.8	
Quebec	27.5	
Ontario	43.3	
Manitoba	3.6	
Saskatchewan	2.4	
Alberta	6.8	
British Columbia	10.0	
Northwest Territories	0.2	
Industry, by sector:		
Primary industries[1]	4.0	
Manufacturing	45.3	
Food, beverages, and tobacco		5.1
Rubber and plastics		2.0
Leather, textiles, and clothing		5.0
Wood and furniture		4.5
Paper		2.4
Printing and publishing		3.4
Primary metals		2.6
Fabricated metals		4.6
Machinery		3.1
Transportation equipment		2.9
Electrical and electronic products		3.8
Chemicals		2.8
Other manufacturing		3.2
Transportation, communications, utilities	6.8	
Trade	13.5	
Finance, insurance, and real estate	5.1	
Services	25.2	
Business		7.6
Health and social		6.6
Other		11.1

1 Includes logging and forestry, and mining.

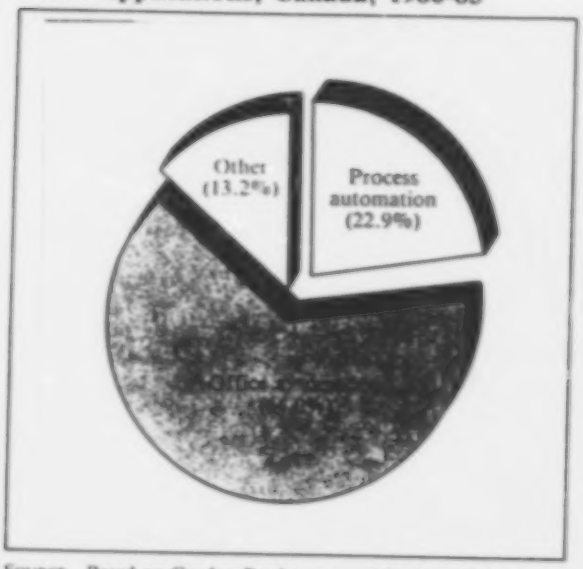
SOURCE Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

aided manufacturing (CAM) and computer-aided design (CAD). Among manufacturers alone, process automation accounted for 37 per cent of all the technological changes reported. The types of concerns that motivated businesses to introduce process technologies were more complex than in the case of office automation. Office innovation was driven fundamentally by productivity objectives. While productivity was also an important factor for process innovation, some important supplementary motivators were identified by respondents. These included improving product quality, reducing labour costs specifically, and increasing control over the production process.

What was the scale of change, and what form did that change take during the first half of the 1980s? One way to consider these questions is to determine the percentage of firms that introduced a particular type of technology during that period. Table 6-2 shows the substantial penetration of office automation technologies between 1980 and 1985, ranging from a high of 87 per cent of wholesale trade establishments to a low of

Chart 6-1

Office, Process, and Other Automation Technologies as a Proportion of Total Applications, Canada, 1980-85



SOURCE: Based on Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

43 per cent of accommodation and food operations. The dominant application in most industries was that of personal computers/workstations. Word processors ranked second, followed by general office applications – for example, personnel, payroll, and sales analysis – for which the type of hardware used was not specified.

Unlike office automation, process technology is most commonly associated with goods production.[4] Close to 43 per cent of the manufacturing establishments reported that some form of process automation was introduced between 1980 and 1985. Within manufacturing, there was considerable variation in the level of penetration of process automation technologies (Table 6-3). The machinery, chemicals, and electrical and electronic products industries were clearly the most active innovators, followed closely by the fabricated metals, paper, and rubber and plastics industries. The printing and publishing industry also introduced substantial process automation, primarily of an industry-specific type. Adoption levels in leather, textiles, and clothing; wood and furniture; and food, beverages, and tobacco – traditionally viewed as "problem" industries – were very low compared with those of the other manufacturing industries.

Popular reports on technological change tend to give the impression that computer-based technologies are quickly becoming a stock item in Canadian factories. The survey results suggest that while the level of pene-

Table 6-2

Office Automation: Scale of Introduction, by Industry, Canada, 1980-85

	Proportion of establishments with:				
	Word processing	Personal computers/ workstations	Office networks	Other office applications	Any office automation
Industry:			(Per cent)		
Primary industries[1]	36.8	44.7	13.2	47.4	73.7
Manufacturing	32.4	43.2	8.2	21.8	62.4
Transportation and storage	17.5	45.0	12.5	17.5	52.5
Communications and other utilities	54.2	58.3	12.5	29.2	79.2
Wholesale trade	37.8	42.2	8.9	44.4	86.7
Retail trade	14.6	20.7	2.4	42.7	59.8
Finance, insurance, and real estate	66.7	62.5	25.0	22.9	77.1
Business services	57.7	64.8	15.5	22.5	78.9
Health and social services	41.9	27.4	6.5	24.2	64.5
Accommodation and food	10.7	33.9	-	12.5	42.9
Other services	35.4	35.4	4.2	18.8	54.2
All industries	34.5	42.6	8.9	25.4	64.6

1 Includes logging and forestry, and mining.
SOURCE: Based on the Working with Technology Survey, Economic Council of Canada, 1985.

Table 6-3

Process Automation in the Manufacturing Sector: Scale of Introduction, Canada, 1980-85

Manufacturing industry:	Proportion of establishments with:					
	Automated material handling	Computer numerical control	Computer-aided manufacturing	Computer-aided design	Automated inspection and quality control	Any process automation
	(Per cent)					
Food, beverages, and tobacco	6.3	6.3	22.9	2.1	8.3	33.3
Rubber and plastics	5.3	5.3	36.8	–	10.5	52.6
Leather, textiles, and clothing	2.1	–	23.4	8.5	2.1	27.7
Wood and furniture	7.1	7.1	14.3	7.1	–	33.3
Paper	17.4	4.3	47.8	4.3	4.3	52.2
Printing and publishing[1]	–	–	15.6	6.3	3.1	25.0
Primary metals	–	12.5	29.2	12.5	8.3	45.8
Fabricated metals	9.3	20.9	30.2	16.3	9.3	53.5
Machinery	10.3	41.4	41.4	31.0	13.8	65.5
Transportation equipment	14.8	11.1	25.9	11.1	11.1	44.4
Electrical and electronic products	16.7	11.1	27.8	44.4	22.2	55.6
Chemicals	26.9	–	26.9	7.7	15.4	57.7
Other manufacturing	10.0	10.0	20.0	10.0	3.3	33.3
All manufacturing	9.2	9.9	26.5	12.7	8.2	43.0

1 In the case of printing and publishing, many of the process technologies introduced, such as automated typesetting, composition, printing, and colour presses, can also be used on a much smaller scale in any office. As a result, these were classified as "other applications." When these are added to process automation for the printing and publishing industry, the total becomes 66 per cent.

Source: Based on the Working with Technology Survey, Economic Council of Canada, 1985.

tration reached by this technology has not been insignificant, process automation is hardly pervasive at this point. Computer-aided manufacturing has the highest incidence overall, reported by roughly one-quarter of all manufacturing establishments; however, less than 15 per cent of establishments in this sector introduced CAD, automated material handling systems, CNC, or automated inspection and quality control in the 1980-85 period. Only in two industries has there been significant penetration of the complete range of process technologies – machinery; and electrical and electronic products.

The predominance of office automation over process automation in the first half of the decade is striking. Some explanation for this pattern can be found in the cost of the technologies. Compared with process automation, office technologies tend to require low levels of investment when they are introduced. For example, the median level of expenditures on word processors was $20,000; on personal computers/workstations, $25,000; and on general office applications, $70,000. In contrast, the median for CAD was $100,000; for CAM, $200,000; and for CNC machines, $400,000. Also, much of the office technology that was introduced consisted of stand-alone equipment – with compartmentalized, rather than comprehensive, effects on operations. Process automation, on the other hand, and the more sophisticated integrated office systems tend to affect whole sets of operations and thus bring more complications. Accordingly, such systems diffused less widely in the first half of the 1980s.

According to survey respondents, however, some changes in these patterns of diffusion are expected to take place in the 1986-90 period. Now that many businesses (though far from all) have been exposed to the relatively simpler and cheaper office technologies, there will be a shift toward more process automation and more sophisticated office technologies.[5] The scale and nature of adjustment required in the last half of this decade may well differ, therefore, from the adjustment that took place in the 1980-85 period.

The Innovators

In this section, we look at the innovativeness of Canadian industry on two dimensions. The first dimension summarizes where computer-based technological change has taken place. Innovators are defined as those estab-

lishments which reported the introduction of any computer-based technology during the 1980-85 period. The advantage of this measure is its simplicity. Either the respondents made computer-based technological changes and are classified as innovators or they did not and are considered non-innovators.

The second class of indicators adds an additional dimension by scaling the magnitude of technological changes where they have been introduced. Two scaling measures are used. The first is financially based and considers the total expenditure made by each respondent on computer-based technologies in the 1980-85 period as a ratio of the establishment's sales over the period. The second scale considers the percentage of employees in each establishment who actually worked with a computer-based technology in 1985. In addition to providing a "people-based" scale, this measure also captures computer technologies that were introduced prior to 1980.[6] Though the two measures of technological intensity might be expected to be related, the relationship is not strong; in fact, they address different aspects of technological intensity. For example, a small office may decide to automate and find that it can do so through the purchase of a few personal computers. Its expenditure on technology may not be great, but a very large proportion of its work force could find itself working with personal computers. On the other hand, a manufacturer may decide to implement a large-scale, expensive factory-automation program but, in the end, have relatively few people actually working with the system on the shop floor. In the first case, the office would score high on the work force-based measure and low on the expenditure-based measure of technological intensity, while the reverse would be true in the second case.

Just over three-quarters of the survey establishments introduced computer-based technological change in the 1980-85 period. A larger proportion – 81 per cent – had employees working with a computer-based system in 1985, indicating that, for some establishments, computer-based automation did take place prior to 1980. On average, 16 per cent of the workers in each establishment were working with computer-based technology in 1985. For over one-half of the respondents, however, the affected work force was less than 10 per cent. Average expenditures on computer-based technologies amounted to just over one-half of 1 per cent of sales over the period.

Is technological innovativeness associated with certain establishment characteristics, such as location, industry, size, ownership, and union status? In terms both of establishments reporting technological change during 1980-85 and of employees working with computer-based technologies in 1985, respondents in the two western regions – the Prairies and British Columbia – were most strongly associated with innovation (Table 6-4). Ontario and Quebec rank highest, however, when the expenditure measure is used. This reflects the concentration of manufacturing activity in these provinces. While manufacturing is fairly close to the sample mean in terms of the other measures of innovativeness, it ranked highest on the expenditure/sales scale.

Table 6-4

Measures of Technological Intensity, by Region, Canada, 1980-85

		Establishment mean	
	Establishments that introduced automation	Employees working with computers, 1985	Expenditures on computer equipment as a proportion of sales
		(Per cent)	
Region:			
Atlantic provinces	66.7	15.0	0.23
Quebec	71.3	10.9	0.58
Ontario	76.2	16.7	0.59
Prairie provinces	81.0	21.1	0.42
British Columbia and Northwest Territories	80.2	21.1	0.45
Canada	75.5	16.1	0.55

Source: Based on the Working with Technology Survey, Economic Council of Canada, 1985.

According to the innovator/non-innovator measure and the percentage of the work force working with the technologies, four industry sectors stood out as being intensive users of computer-based technologies: communications and other utilities; wholesale trade; finance, insurance, and real estate; and business services (Table 6-5). The retail trade sector also scored high on percentage of the work force working with the technologies. The primary sector (forestry and mining), transportation, and health and other services were low on technological intensity within establishments and roughly average in terms of industrywide adoption of computer-based technologies. As has already been noted, manufacturing ranked very high on the measure based on expenditures on the technologies.

Within manufacturing, there was considerable variation in innovativeness (Table 6-6). The printing and publishing industry was high in terms of overall industry innovativeness and intensity of use within establishments; and the machinery, chemicals, and electrical and electronics industries ranked well on two of the measures. In contrast, leather, textiles, and clothing; wood and furniture; and primary metals ranked low on all three measures.[7]

Not surprisingly, given the wider range of opportunity faced by larger establishments, the likelihood that some computer-based technology was introduced between 1980 and 1985 increased with the size of the establishment (Table 6-7). When differences in technological intensity are considered, however, the relationship with size disappears.[8] In other words, the intensity of use of computer-based technologies within establishments was not related to establishment size; nor was the financial commitment larger for one size class, compared with the others.

The question of the impact of foreign (particularly U.S.) investment on Canadian innovation performance has long been a contentious issue in this country. Earlier research has found that while foreign-controlled firms do tend to do less research and development than Canadian-controlled firms, they compare quite favourably when the use of advanced technologies is concerned.[9] The WWTS results clearly point to the same conclusion. While the R&D/sales ratios of U.S.-controlled establishments were substantially lower than those of Canadian-controlled establishments, they outperformed Canadian-controlled establishments in overall innovativeness (Table 6-8). In terms of the percentage of establishment employees working with computer-based technologies, respondents with foreign (particularly U.S.) parents were typically more technologically intensive than their Canadian counterparts. The U.S.-controlled respondents also tended to invest

Table 6-5

Measures of Technological Intensity, by Industry, Canada, 1980-85

		Establishment mean	
	Establishments that introduced automation	Employees working with computers, 1985	Expenditures on computer equipment as a proportion of sales
Industry:		(Per cent)	
Primary industries[1]	76.3	8.1	0.14
Manufacturing	76.1	13.9	0.73
Transportation and storage	60.0	16.8	0.26
Communications and other utilities	87.5	23.4	0.46
Wholesale trade	91.1	22.6	0.31
Retail trade	74.4	25.3	0.34
Finance, insurance, and real estate	79.2	25.2	0.31
Business services	81.7	23.3	0.57
Health and social services	75.8	6.5	0.30
Accommodation and food	60.7	12.6	0.23
Other services	62.3	10.8	0.21
All industries	75.5	16.1	0.55

1 Includes logging and forestry, and mining.
Source: Based on the Working with Technology Survey, Economic Council of Canada, 1985.

Table 6-6

Measures of Technological Intensity, by Manufacturing Industry, Canada, 1980-85

		Establishment mean	
	Establishments that introduced automation	Employees working with computers, 1985	Expenditures on computer equipment as a proportion of sales
		(Per cent)	
Manufacturing industry:			
Food, beverages, and tobacco	79.2	13.7	0.06
Rubber and plastics	68.4	14.0	0.93
Leather, textiles, and clothing	48.9	1.9	0.20
Wood and furniture	61.9	6.5	0.35
Paper	78.3	12.0	0.86
Printing and publishing	87.5	24.0	1.11
Primary metals	66.7	5.8	0.56
Fabricated metals	83.7	16.0	0.80
Machinery	89.7	17.1	1.13
Transportation equipment	81.5	11.9	1.12
Electrical and electronic products	86.1	25.1	0.59
Chemicals	88.5	24.0	0.38
Other manufacturing	80.0	16.1	1.90
All manufacturing	76.1	13.9	0.73

Source: Based on the Working with Technology Survey, Economic Council of Canada, 1985.

Table 6-7

Measures of Technological Intensity, by Establishment Size, Canada, 1980-85

		Establishment mean	
	Establishments that introduced automation	Employees working with computers, 1985	Expenditures on computer equipment as a proportion of sales
		(Per cent)	
Establishments, by number of employees:			
50 or fewer	54.9	17.3	0.41
51 - 100	66.8	15.9	0.76
101 - 500	85.9	15.1	0.56
More than 500	98.9	17.1	0.55
All establishments	75.5	16.1	0.55

Source: Based on the Working with Technology Survey, Economic Council of Canada, 1985.

more of their revenues in these technologies than did domestically controlled establishments.

The relationship between unionism and technological change is uncertain. Among WWTS respondents, unions do not appear to be a barrier to the adoption of computer-based technologies; in fact, unionized establishments were more likely than non-unionized ones to have introduced some computer technology between 1980 and 1985. With respect to the relative

Table 6-8

Measures of Technological Intensity, by Control of Establishments, Canada, 1980-85

		Establishment mean		
	Establishments that introduced automation	Employees working with computers, 1985	Expenditures on computer equipment as a proportion of sales	R&D spending as a proportion of sales
	(Per cent)			
Domestic- and foreign-controlled establishments:				
Canadian	72.5	15.7	0.55	3.54
Foreign				
United States	94.1	18.5	0.66	1.14
Other	87.5	17.4	0.38	5.19
All establisments	75.5	16.1	0.55	3.30

Source: Based on the Working with Technology Survey, Economic Council of Canada, 1985.

expenditures on these technologies, however, there was very little difference between the two groups. And in terms of the percentage of employees working with the technologies, the average for the non-union respondents was nearly 5 percentage points higher.

To what extent, then, do the characteristics of establishments – in terms of industry, location, size, and so on – explain the patterns of variation in technological intensity? While the survey data suggest some relationships, at the same time, only a small part of technological intensity can be attributed simply to the structural characteristics of the innovating establishments. This suggests that, while the scope for technical advance may vary somewhat for different types of firms, the extent to which establishments innovate is decided by more "behavioural" factors. Considerable organizational choice appears to be exercised in the adoption of computer-based technologies.

Do innovators and non-innovators differ in terms of employment and output trends? This question is particularly relevant given the interest in the relationship of technological change to employment and firm performance. When we compared the employment and sales growth of the survey respondents according to their innovativeness, we found that, regardless of the measure of technological intensity used, growth rates were significantly greater for high-technology than for low-technology establishments.

Does the introduction of computer-based technologies *cause* higher employment and sales growth? This question is extremely difficult to answer since so many factors besides technology work together to influence business performance, not the least of which are national, and even international, economic conditions. Upon closer examination, we find, in fact, that the strongest influence on employment growth is sales growth itself; businesses that are successful in expanding their sales tend to hire more people. Sales growth, in turn, is influenced by a number of factors, one of which is technological intensity. At the same time, it should be recognized that successful businesses will have more to invest in technology.

Our results, then, suggest that the number of jobs grew more rapidly in technologically intensive firms. This, however, cannot be interpreted to mean that technological displacement did not occur. Indeed, many survey respondents indicated that technological changes were introduced for labour-saving reasons. Computers may well have reduced labour requirements for specific functions; moreover, there is no guarantee that the same individuals were employed after innovation had taken place. Any employment reduction that did occur, however, was offset by increases in the volume of business among innovators, who also experienced higher rates of productivity growth.

An International Comparison

The diffusion of innovations and technological change can span a period of several years, or even decades. Some firms are early adopters, while others lag; and some never adopt a particular technology. Generally, Canadian performance in terms of innovativeness

has not compared well with that of our major competitors. Work by the Council earlier in this decade showed that Canadian firms tend to be slow when it comes to the introduction of new technologies.[10]

According to the European Management Forum's (EMF) *1986 World Competitiveness Report*, we have made some progress in recent years in improving our overall competitive position.[11] Canada ranked sixth among the 22 OECD countries but, nevertheless, well behind the three leaders – Japan, the United States, and Switzerland. The EMF report identified problems with productivity growth, capital investment, and technology development in this country. In terms of the latter, the United States continues to lead, while Canada ranks in the bottom 25 per cent. According to the EMF, Canada also lags seriously in the rate of introduction of factory automation.

An accurate picture of how Canada is now faring in terms of the diffusion of computer-based technologies is not easily drawn. Data of the sort generated by the WWTS are not available in many countries. Moreover, even where information does exist, international comparisons are not always possible: for example, definitions of specific technologies can vary in different countries. Difficulties notwithstanding, the adoption of new technologies in Canada relative to that of our major economic partners is an interesting question and one that we have tried to address in our research.

International data on levels of use are available for robots and for numerically-controlled (NC) machine tools. In 1984, Canada lagged considerably behind Japan and Sweden in robot use (Table 6-9). Another estimate places Canada three to four years behind the United States in robot technology.[12] In 1983, NC machine tools represented 4.4 per cent of all machine tools in use in Canada, placing us well behind Japan at 38.1 per cent. In the United States in 1983, NC tools amounted to 12.9 per cent of machine tools in use; in the United Kingdom, the percentage was 8.1.[13] Another, more recent study focused only on Japan and the United States. It concluded that since 1980, spending on automation in Japan has been twice that in the United States. In the last five years, 55 per cent of the machine tools introduced in Japan were CNC machines, while in the United States, the proportion was only 18 per cent.[14] Since 1975, more than 40 per cent of the worldwide CNC machine base has been installed in Japan, mostly in small and medium-sized companies. Furthermore, the intensity and effectiveness of use of microelectronics is argued to be far superior in Japan.

Other evidence on Japan is available from a 1982 survey of manufacturing establishments employing 100 or more workers. In terms of specific microelectronic technologies, manufacturing processes involving machining and painting had the highest diffusion rates (89 per cent), followed by inspection (52 per cent), assembly (48 per cent), and internal factory transport (27 per cent).[15] The WWTS provides roughly comparable – and much lower – figures for Canada for two of these technologies: 10 per cent of manufacturing establishments employing 100 or more workers reported the introduction of automated inspection and quality control between 1980 and 1985, and 13 per cent introduced automated material handling equipment.[16] The highest levels of use were recorded by very similar industries in both Japan and Canada – namely, machinery, printing and publishing, and some processing industries. The Japanese survey found that 60 per cent of the factories surveyed were using some type of microelectronic equipment in 1982. By 1985, Canada had apparently reached roughly that level: 58 per cent of the WWTS manufacturing establishments employing 100 or more workers reported that they had introduced some computer-based technology in their production process. While this evidence is limited in that it does not consider the scale of use within establishments, it suggests that at least for medium and large manufacturers, Canada may be at least three years behind Japan.

A substantial Canadian lag is also apparent when comparison is made with major European countries.[17] A survey of manufacturing establishments in Britain, Germany, and France indicates that the levels of adoption of computer process technologies in those countries in 1983 were higher than in Canada in 1985 (Chart 6-2). As was the case for Canada, the proportion of users increased steadily as the size of establishment increased. In each size category, however, Canada lagged substantially behind Germany and, to

Table 6-9

Robots per 10,000 Persons Employed in Manufacturing, Various Countries, as of January 1, 1984

	Number of robots		Number of robots
Japan	32.1	Belgium	5.9
Sweden	20.2	United States	4.7
West Germany	7.2	Italy	3.9
Czechoslovakia	7.2	Canada	3.7
France	6.9	United Kingdom	3.1

Source: Ontario Ministry of Industry, Trade and Technology, *Flexible Automation Equipment* (Toronto: ITT, 1985), p. 38.

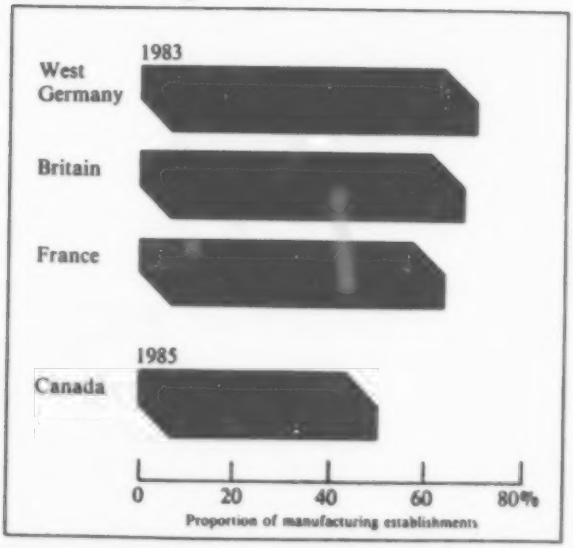
a lesser degree, behind Britain and France. The gap was largest when establishments employing 500 people or more were compared.

Part of the Canadian gap may be explained by differences in behaviour between domestic- and foreign-controlled firms in Canada. The level of penetration of process technologies in Canadian-controlled manufacturing establishments, at 38 per cent, was substantially less than the 59 per cent for foreign-controlled establishments. This finding holds for nearly every technology included in the survey, with the exception of CAD and general office applications. The Canadian/European gap was mainly attributable to much lower adoption levels among Canadian-controlled establishments in the medium-size category.

Three conclusions can be drawn from this evidence. First, Canada lags behind most other advanced economies in the use of computer-based process technologies. This lag is quite considerable when comparison is made with Japan. Canada also lags behind the United States, which, in turn, is held to be much less effective than Japan in the management of microelectronic technologies. Second, the fact that the extent of use of microelectronics in process applications increases with firm size in Britain, Germany, France, and Canada shows that the small-establishment lag, though no less serious, is not unique to Canada. As the European researchers suggest, this difference reflects the wider range of possibilities open to larger factories, the greater complexity of their operations, and, perhaps most importantly, ". . .the larger establishments' greater awareness of the potential scope for applications and their greater technical and financial resources for exploiting them."[18] Third, the evidence from the WWTS suggests that at least part of the Canadian lag in the use of process automation in manufacturing may be attributable to lower adoption levels among medium-sized, Canadian-controlled establishments and among the largest establishments, both Canadian- and foreign-controlled.

Chart 6-2

An International Comparison of the Use of Microelectronics in Manufacturing Processes



SOURCE Based on data from J. Northcott and P. Rogers, *Microelectronics in Industry: An International Comparison - Britain, Germany, France*, No. 635 (London: Policy Studies Institute, 1985) p. 15; and from the Working with Technology Survey, Economic Council of Canada, 1985.

Obstacles

Certainly, in some situations, new technologies are not adopted because they are simply not beneficial or even suitable for an establishment. By no means does the blind application of technology for technology's sake provide a quick-fix for ailing businesses. And the process of innovating, and innovating successfully, is often a difficult one. A variety of obstacles - financial, technical, and social - may be encountered in this process.

The survey data provide some indication of the difficulties that must be overcome. Financial obstacles appear to be the most common.[19] More than half of the respondents cited equipment costs and 31 per cent identified low return on investment as obstacles to technological change. In comparison, technical barriers seem less important; nevertheless, they were targeted by a substantial minority of establishments surveyed. Just under one-third identified problems finding technically qualified personnel, and 23 per cent noted difficulties in integrating the technologies with systems already in place.[20]

The survey offers little support for the contention that the major barriers to innovation are often social. Problems associated with employee and management reluctance were cited by only 20 per cent and 13 per cent of the establishments, respectively. Similarly, restrictive collective agreement provisions - another commonly perceived impediment to innovation - were cited as a barrier by less than 10 per cent of the survey participants.

Not a single respondent identified cost of training as a significant obstacle. This may reflect the fact that, as

we shall see, most of the technology-induced training provided was of fairly short duration and not overly costly, partly because much of the innovation introduced during 1980-85 consisted of relatively uncomplicated office technologies. If this is the case, with the forecast move toward larger and more sophisticated process and office automation technologies to 1990, it may be that training will develop into more of an issue in the future.

Planning

The innovation process involves a number of critical decisions regarding, for example, the types of new technologies required, the scale of implementation, and the reorganization of the work process. Each of these can affect the number and quality of jobs in the establishment. Accordingly, the planning process – arriving at those decisions – is particularly relevant for a study concerned with the employment impacts of technological change. In our view, effective management of innovation involves careful consideration of both the technical and social aspects of change. This can best be carried out by including all affected parties in the planning process.

The traditional practice, of course, is for managers, alone, to decide on changes in operations. According to the survey results, management in some situations is now bringing others into the innovation planning process (Chart 6-3). This is particularly true for large organizations where, presumably, the scale and sophistication of technological change, as well as available resources, lead to more complex implementation strategies. It is not unusual, especially for large firms, to involve consultants and technical vendors in the planning process. Among survey respondents with more than 500 employees, over half reported the participation of technical experts in the implementation of technological changes. In our case studies of large establishments, their involvement was quite apparent: indeed, we noted that vendor capabilities in terms of designing a specific application and in terms of post-implementation support are becoming a criterion in system selection.

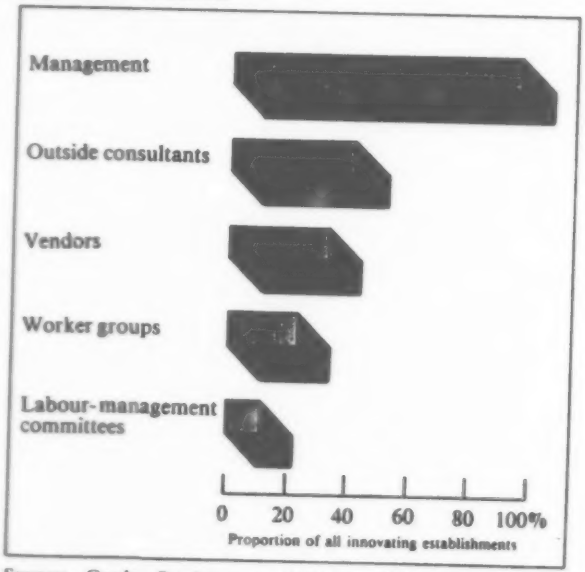
While managers may increasingly be bringing technical help into the planning process, it seems that the innovation-design team is less likely to include workers or their representatives. The involvement of worker groups and joint (labour/management) committees was reported by just 23 per cent and 11 per cent of the survey innovators, respectively. This apparent lack of participation is consistent with results of much of the research carried out under the Labour Canada's Technology Impact Research Fund initiative.[21] A common theme of a number of these generally union-sponsored projects is inadequate consultation between management and workers. This issue will be taken up in a later chapter on industrial relations and technological change.

Two of our case studies focused on the innovation-planning process, and while the efforts of both organizations were impressive in this area, we saw little evidence of direct labour involvement. This is not to say that employment issues were excluded. In addition to extremely sophisticated technical planning, social questions were very much a part of what were comprehensive design processes in both situations.

The focus of one case was the preparation by an aircraft-engine manufacturer for a new, computer-integrated plant.[22] The technical system was conceived in precise terms years in advance of the anticipated plant opening. While the development of the social system appears to have begun later, it has been planned in comprehensive fashion, from the identification of a desired corporate culture through to the design of specific jobs. The second case is a pulp and paper company that is modernizing one mill and building another. Here, too, considerable planning of employment-related issues,

Chart 6-3

Groups Actively Involved in Planning for Technological Change, Canada, 1980-85



SOURCE Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

particularly retraining, accompanied the technical preparations. Both this company and the aircraft-engine manufacturer have hardly ignored employment questions in innovation planning. In fact, in both cases, consultants specializing in social-system design have played important roles, along with management and vendors, in planning for the introduction of new technologies. In neither situation, however, do workers appear to have had any important, direct involvement.

Adjusting to Technological Change

What are the implications of technological changes for employment within innovating firms? In what ways do the new technologies alter the types of jobs, and hence the skills needed? How are the new skill requirements met? On balance, our research suggests that computer technologies are touching more and more jobs within Canadian firms. Up to this point, white-collar work has been affected the most, but if the innovation plans reported by survey respondents hold true, blue-collar work will be increasingly affected in the next few years.

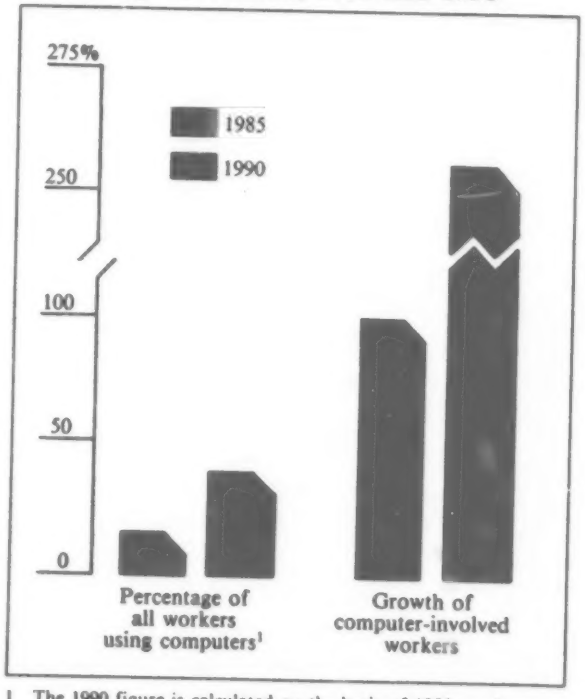
To this point, most innovating establishments appear to have adjusted to changing labour requirements without serious problems. This does not mean that the effects of computer technologies should not be of concern. In the first place, as we shall discuss below, it seems likely that the labour adjustment task will be more challenging for firms in the future than it has been in the past. Second, the introduction of new technology can clearly involve difficult adjustments for affected workers. A variety of uncertainties accompany technological change from the employee's point of view: existing skills and responsibilities and, most seriously, job security may be threatened. Indeed, the harmful implications – in the form of de-skilling, to cite one example – have received a lot of attention. Many observers have argued that automation tends to reduce the need for the vocational skills of workers.[23] Where this is the case, employees lose a critical determinant of their overall satisfaction with their jobs. A principal conclusion of our organization studies is that the impacts of technological change can vary considerably. The way in which firms implement change is the key. Adjustment is eased substantially where innovating organizations make a commitment to their work force. Moreover, there is some evidence that this approach leads to gains in overall efficiency.[24]

Computer-based technological change is affecting the working lives of increasing numbers of people. Survey respondents reported that 16 per cent of their employees used these technologies in their jobs in 1985. Primarily because of the focus to that point on office applications, women were more likely to be affected than men.[25] According to the survey results, the probability of working with computers in one form or another will more than double over the last half of the 1980s (Chart 6-4). To express the growth another way, for every 100 people who worked directly with computer technologies in 1985, there will be 262 by the end of the decade.

Earlier in this chapter, we pointed out that the rising application of process technology is expected to feature prominently in Canadian innovation over the last few years of the 1980s. The numbers of people working with these types of automation are anticipated to grow dramatically. Among firms participating in the survey, employees using robots, automated inspection and quality control, and computer-aided design are projected to more than triple over the 1985-90 period (Chart 6-5). Though there will also be significant growth in the extent

Chart 6-4

Actual and Projected Proportion and Growth of Work Force Using Computer Technologies, Canada, 1985 and 1990



1 The 1990 figure is calculated on the basis of 1985 employment levels and 1990 projections of computer-involved workers.

SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

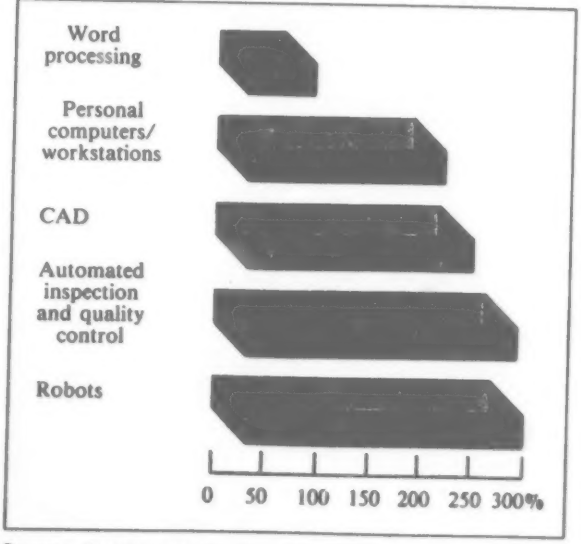
to which workers will use office technologies, particularly personal computers and word processors, it will be less dramatic. This largely reflects the fact that a considerable amount of technological change had already taken place in the office by 1985.

In 1985, over 30 per cent of the work force in finance, insurance, and real estate, and in wholesale trade, and over 20 per cent in communications and utilities, and in business services, were already using computers in their jobs (Table 6-10). Survey establishments project that the majority of employees in the first three industries – including virtually everyone in wholesale trade – will be working with computer technology by the end of the decade. As evidence of the growing importance of process innovation, the share of the work force in the primary and manufacturing sectors using computer technology on the job is expected to increase considerably by 1990.

In 1985, workers in smaller organizations were nearly as likely to use computers as their counterparts in larger establishments. To the end of the decade, however, the computer-affected work force in large firms is going to grow more quickly. Among the WWTS respondents, those with 100 or fewer workers expect 28 per cent of their employees to be using computers by 1990, while the corresponding figure for those with more than 100 employees is forecast to be 41 per cent.

Chart 6-5

Projected Growth of Workers Using Selected Technologies, Canada, 1985-90



SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

Table 6-10

Actual and Projected Computer-Affected Work Force, by Industry, Canada, 1985 and 1990

	Proportion of total work force affected[1]	
	1985	1990
	(Per cent)	
Primary industries[2]	10.9	39.7
Manufacturing	12.8	34.7
Transportation and storage	8.4	24.0
Communication and other utilities	26.1	66.2
Wholesale trade	32.0	96.7
Retail trade	16.7	23.0
Finance, insurance, and real estate	36.1	59.5
Business services	21.1	41.0
Health and social services	7.5	39.9
Accommodation and food	14.5	15.9
Other services	4.3	13.7

1 Calculated as percentage of total employment in 1985.
2 Includes logging and forestry, and mining.
SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

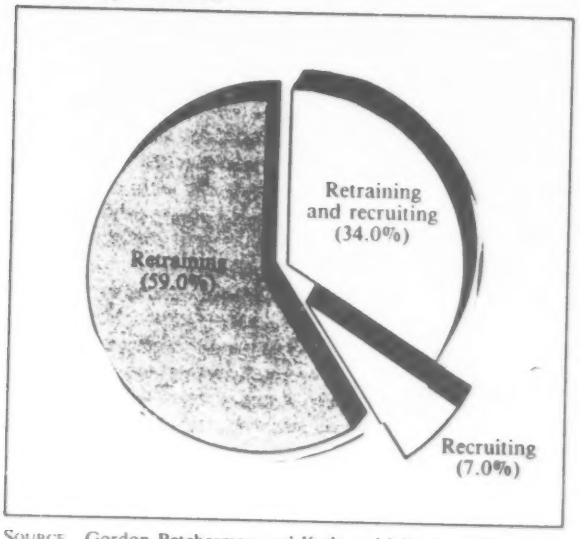
From an employment point of view, it is important to ask to what extent this innovation is actually changing work. Obviously, the adjustment required on the parts of firms and workers depends very much on this. According to 72 per cent of the survey respondents who innovated over the 1980-85 period, the technological changes did lead to the creation of new types of jobs or substantially modified existing ones. Where technological change results in new or substantially changed skill requirements, establishments can adjust by external recruiting, retraining existing workers, or some combination of both. Strategies involving retraining dominated among survey respondents (Chart 6-6). As we shall see below, firms facing a "make" or "buy" decision tended to choose recruiting only when the skills required by the new technologies were of a high level.

Meeting New Skill Requirements

Certainly in some situations, technological change can stimulate a great deal of retraining in a wide range of occupations and skill levels. For this to happen, new technologies must create major changes in skill requirements. Also, the establishment must have a strong commitment to its existing work force. Both of these conditions were evident in the pulp and paper company in New Brunswick that we studied. The operations

Chart 6-6

Strategies Used by Innovators for Meeting New Skill Requirements Resulting from Technological Change, Canada, 1980-85



SOURCE Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

included two existing pulp mills and a paper mill that was being brought on stream at the time of our field work. In addition to the state-of-the-art technology that was being put into the new plant, the older of the pulp mills was undergoing almost complete modernization. The company and the union had agreed on a staffing approach for the paper plant that gave workers in the pulp operations priority for the highly paid jobs in the new plant. Moreover, the pulp-mill positions vacated by those selected were filled by other workers through an internal bumping procedure; their jobs, in turn, were filled in similar fashion.

The net result was that virtually all of the employees in the revamped operations required retraining. In addition to the sheer magnitude of this training effort, the pulp and paper company's approach had a number of interesting features. Particularly impressive was the systematic planning undertaken to identify training needs and to arrange for the necessary retraining to meet the production schedule. Assembling a training staff represented one potential problem that was met through a "train-the-trainer" method, in which selected operators received training not only in a vocational skill created by the new technology but, also, to become a trainer for that occupation. These operators developed extensive manuals on which structured courses were based. In the paper plant, a multi-skill approach was adopted, where employees received training for their own position and for the two jobs immediately above them in their production area. There are a variety of benefits to such multi-skilling: for the worker, there is the challenge and reward of learning more than just how "one cog in the machine" works; for the company, it pays off in increased effectiveness, improved problem-solving, and more flexibility.

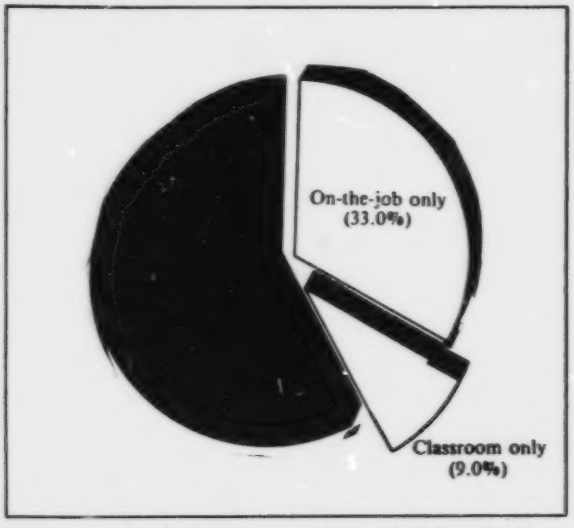
The survey results suggest that the scale and depth of the retraining effort undertaken by that pulp and paper company is not typical of the retraining that most innovating establishments have tended to carry out. Computer-based technological change is usually accompanied by some retraining, but much of it appears to be informal and relatively unstructured, integrating computer technology with existing vocational skills. Overall, the survey does not provide evidence of major skills development on the part of Canadian industry in response to the new technologies introduced to this point.

It is possible, of course, that much of the innovation, particularly in the office, simply has not demanded that type of retraining effort. Even if this is the case, technology-driven training is likely to become a stronger imperative with the scale and types of technical innovations that are planned for the rest of the decade. It may well be, however, that our results point to an overall undertraining in response to the introduction of technological change. It should be recalled that nearly one-third of the survey respondents identified a lack of technically qualified personnel as an obstacle to innovation. The adequacy of skills development within Canadian industry has often been questioned. Indeed, according to recent evidence, employees in this country average two hours of in-plant training annually, compared with the 100 to 200 hours received by their counterparts in Japan.[26]

According to our survey respondents, the typical retraining necessitated by technological change was on-the-job training for clerical personnel, which usually lasted less than 10 weeks. The dominance of the on-the-job method – generally low-cost and probably often unstructured – is shown in Chart 6-7. Small firms, in particular, seemed to rely on on-the-job training to meet any new skill requirements resulting from technological change. When classroom retraining was reported, it was of extremely short duration in most cases (Table 6-11). Indeed, 56 per cent of all classroom programs were over within a week, with less than 2 per cent lasting for at least six months. In terms of total duration – classroom and on-the-job components combined – one out of two training efforts took less than a month.

Chart 6-7

Types of Programs Used for Retraining Necessitated by Technological Change, Canada, 1980-85



SOURCE Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

The technology-driven retraining reported by survey respondents was heavily concentrated in white-collar skills. Only 12.6 per cent of the retraining programs were for blue-collar occupations. This, of course, follows from the relative importance of office automation among the innovations introduced up until 1985. Just over one-third of all workers being retrained because of technological change were clerical employees (Table 6-12). Particularly dominant in this group were typists and data-processing clerks, accounting for 10.4 and 6.8 per cent of the total retraining complement, respectively. Next in importance, but far less common than clerical training, was the retraining of personnel in sciences and engineering, and in managerial occupations.

Is the technology-driven retraining effort likely to change as process innovation becomes more important in the remainder of the decade? Certainly it seems logical to expect that blue-collar occupations will be more involved in training as the rate of introduction of CAM, CAD, and other process technologies increases. From our research, however, we have observed that little of the retraining driven by these technologies has been focused on semi- or unskilled employees. Among survey respondents, for example, a substantial share of the blue-collar training was directed at highly skilled electronic installing and repair occupations, and at machinists and machine set-up occupations. In our study of an automobile-engine manufacturing plant, we focused on technical training for new production technologies.[27] Computerized process innovations at this plant included laser bar-coding, automated quality control,

Table 6-11

Duration of Retraining Programs Resulting from Technological Change, by Method of Training, Canada, 1980-85

	Proportion of total programs in each category:		
	On-the-job	Classroom	Total
	(Per cent)		
Number of weeks:			
One	18.6	56.0	20.3
2 - 4	32.3	27.2	30.4
5 - 12	16.3	9.5	17.6
13 - 26	24.6	5.7	18.6
More than 26	8.2	1.6	13.1
Total	100.0	100.0	100.0

SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

Table 6-12

Work Force Retrained Because of Technological Change, by Occupational Group, Canada, 1980-85

	Proportion of all trainees
	(Per cent)
Occupational group:	
Clerical	33.7
Sciences and engineering	13.6
Managerial and administrative	11.9
Product fabricating, assembly, and repair	5.1
Sales	4.3
White-collar, unspecified	14.1
All other groups	17.3
Total	100.0

SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

robots, machine vision, and statistical process control.[28] The establishment, itself, has an awareness of the importance of training; in fact, there is a large training centre on site. While skilled trades personnel, particularly in electronics, received a great deal of training for the new technologies, there appeared to be relatively little formal technical training given to less skilled operators, at least over the period that we examined. The approach apparently adopted by the establishment's management was to focus technical training on the engineering staff and then encourage the informal transfer of that knowledge through supervisors and skilled trades personnel within the plant.

Where it was instituted, did blue-collar training differ from the short-term, largely on-the-job activity that characterized the white-collar programs? There is some evidence from the survey that process innovation leads to more mixed (classroom/on-the-job) training than is the case with office automation.[29] The length of training appears to vary depending on the level of skill involved (Table 6-13). For example, machining occupations – for the most part, high-skill occupations – tended to undergo relatively long-term programs, while largely unskilled or semi-skilled product fabricating, assembly, and repair, and processing occupations, did not. With the greater introduction of process technologies, our results suggest that the intensity of the retraining effort should increase, at least for skilled workers. It is quite possible, as well, that the heightened scale and complexity of process innovation that is likely for the remainder of the decade will change the nature of the training required for all workers.

Table 6-13

Average Duration of Retraining Programs Resulting from Technological Change, Selected Occupational Groups, Canada, 1980-85

	Average duration of programs
	(Weeks)
Occupational group:	
Clerical	9.4
Sciences and engineering	18.6
Managerial and administrative	17.1
Machining	26.7
Product fabricating, assembly, and repair	14.4
Processing	7.4
All occupations	12.5

SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

While retraining because of technological change has been the dominant adjustment strategy, recruiting has generally been the response to higher-level skill requirements created by the changes. Over one-quarter of the people recruited by survey establishments as a result of technological change were in sciences and engineering occupations (Table 6-14). By far the most commonly sought-after workers were computer programmers and systems analysts, representing 16.8 per cent of all recruits. Engineers and technologists specializing in electronics were also frequently hired in innovation situations. While these sciences and engineering personnel were often recruited in the local labour market, it is interesting to note that the postsecondary education system was also an important source.[30]

Other Adjustments

To this point we have focused on how firms meet the new skill requirements created by the introduction of technological change. While this is an important aspect of the human resource response to technical innovation, other adjustments, particularly with regard to redundant workers, may also be required. Redundancies arise in innovation situations for two reasons: first, new technologies may reduce the number of jobs; second, they may change the types of jobs, rendering existing skills obsolete. As we have seen, technological changes are introduced to increase productivity – requiring less spending to produce a given amount – more often than for any other reason. Since labour represents a major cost factor in most operations, productivity-enhancing technological change often implies a decrease in the number of workers needed.[31]

Table 6-14

Recruits Hired in Response to Technological Change, by Occupational Group, Canada, 1980-85

	Proportion of total recruits
	(Per cent)
Occupational group:	
Clerical	15.9
Sciences and engineering	27.7
Managerial and administrative	3.7
Product fabricating, assembly, and repair	15.2
Machining	7.6
White-collar, unspecified	3.9
All other groups	26.5
Total	100.0

SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

Whether or not employment levels do fall, innovating firms may decide that certain workers are expendable because their skills are no longer required in the new way of doing things. There is growing recognition now, however, that "best practice" management involves a commitment to the existing work force.[32] In this type of approach, change is accepted as part of the organization's experience, and in return for a willingness on the part of workers to accept shifting responsibilities and to undergo retraining, employment security is assured to the extent feasible.

We saw some evidence of a "commitment" style in a few of the firms that were subjects of our case studies. The pulp and paper company provides one good example, specifically with respect to its older workers. Too often, these employees are not seen as good candidates for learning computer technologies and, accordingly, are excluded from post-innovation plans. In this firm, there were a number of older workers, particularly in the modernizing pulp mill – many with little education, poor literacy skills, and insecurity regarding the new production methods. By adopting a positive attitude, the company appears to have addressed the difficulties effectively, and the retraining of these people has been largely successful. The commitment model adopted by this firm, and others, seems to offer benefits to both employers and existing employees. It should be noted, however, that this approach tends not to generate job opportunities for individuals in the labour market who are searching for work.

How do Canadian establishments deal with the question of technological redundancy? Unfortunately, this is not a simple question to answer. The number of jobs may be cut, but the specific reason for the reduction will not always be evident. In the course of our case studies, we found a number of situations where companies that had experienced difficult times during the recession in the early 1980s had – in seeking increased productivity and competitiveness – introduced technical innovations, redesigned jobs, increased work intensity, and laid off workers. In these "rationalizing syndromes," what is the precise cause of the layoffs?

While employer survey data should be considered with some caution here, the WWTS did ask innovators what methods they used to handle any reduced demand for workers because of technological change (Table 6-15). Two-thirds of those establishments reported that technical innovations had required some response to deal with redundancies. The most frequently cited measure was a transfer. While this is often an ideal solution, transfers are naturally most suited to large operations, where appropriate positions for displaced workers are more likely to be available. Only 10.4 per cent of innovating establishments reported technology-induced layoffs; again, however, it is difficult to interpret this figure. Medium-sized establishments (101 – 500 employees) and the manufacturing sector reported the highest incidence of layoffs. Providing incentives for early retirement and for the sharing of available work through reduced hours and part-time arrangements have received some attention as innovative measures to adjust work forces to technological change. Among the survey establishments, however, these measures have not been widely adopted.

Table 6-15

Personnel Adjustments to Technological Change, Canada, 1980-85

	Proportion of innovators using each method[1]
	(Per cent)
Methods of adjustment:	
Transfers	44.0
Internal	43.1
External	4.6
Layoffs	10.4
Temporary	2.4
Permanent	9.4
Early retirement	6.4
Reduced hours/part-time work	9.9
Some type of redundancy adjustment	**66.5**

1. Multiple responses were possible.

Source: Based on Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

Conclusion

For a comprehensive understanding of the employment implications of technological change, it is important to consider the innovation experiences of individual firms. Through our survey of nearly 1,000 establishments and the more in-depth case studies of a handful of organizations, we have looked at the kinds of technological changes that are being introduced and the labour adjustments that accompany them. In the next two chapters, we shall broaden our attention to consider the implications of the new technologies for organizational change and industrial relations.

The WWTS has provided us with some valuable insights into the innovation behaviour of Canadian businesses in the 1980s. By 1985, about 75 per cent of the

survey respondents had had direct experience with computer-based technological change; by 1990, that figure is expected to rise to 85 per cent. At the same time, Canada is still behind its major economic partners in adopting computer technologies, at least in the manufacturing sector.

To date, the Canadian experience has been limited in large part to office automation. Process automation on any significant scale has been implemented in very few manufacturing industries. Some change in this pattern is expected for the period 1986-90, with process technology assuming a greater share of innovation activity. In terms of industries, even more change is expected in those which have already experienced substantial computer-based technological change – namely, communications and other utilities; finance, insurance, and real estate; and business services. An important addition to this list is manufacturing, where it is expected that the proportion of firms introducing process automation will increase significantly.

The dominance of office automation in the first half of this decade has meant that, on balance, it has been the white-collar occupational groups that have been faced with the greatest requirement for adjustment. With the expected shift toward more process automation in the near future, however, blue-collar workers can expect to encounter more technological change in the workplace.

Computer-based technological change is clearly affecting increasing numbers of workers and organizations in this country. Wholesale reorganizations have, in some instances, accompanied technological change; and, clearly, difficult adjustments on the part of individual workers have been made. To this point, however, our research suggests that Canadian firms have not undergone major human resource adjustments. The technology-driven retraining that has been carried out appears to have been of a short duration and unstructured nature, aimed predominantly at integrating the new technologies with existing skills.

This retraining effort may indicate an underestimation by Canadian employers of the optimal level of response to the new technologies. Alternatively, it could reflect the nature of the technological changes that have predominated to this point. Typically, the innovations reported by WWTS respondents were relatively small, nonintegrated office applications, with only modest skill effects. In the remainder of this decade, however, larger-scale and more integrated automation is expected to become increasingly important, in both the office and the plant. The limited innovation of this level of sophistication to date has required more-intensive retraining, specifically in the skilled occupations. Accordingly, we anticipate that the human resource responses required by technological change may well be more challenging in coming years.

7 Organizational Change

In 1975 the Swedish auto-maker Volvo abandoned the machine-paced assembly-line technology at its plant in Kalmar. The adoption of special carriers to take engines or car bodies to individual work units was a break with a worldwide mass-production tradition stretching back to Henry Ford. Little wonder, then, that close to 100,000 visitors went to Kalmar in its first year of operation. What was so revolutionary, however, was not so much the change in the technology; nor was it the emphasis on a more participatory approach to workplace relations, for the Scandinavians had long enjoyed a reputation for enlightened labour practices. Rather, it was the notion that not only could a better quality of work life lead, through increased job satisfaction and motivation, to "bottom-line" payoffs in productivity, quality, lower absenteeism, and fewer strikes, but technological change could help bring this about.

This famous example illustrates a principal theme of this chapter – the fact that technological change and organizational change are inextricably interrelated. A new machine, material, product, or process inevitably involves changes in the nature of jobs, the way work is organized, and the social relations of people at work. Tomorrow's technology will not fit yesterday's workplace. So innovation means much more than advanced machinery and equipment. It also means constantly implementing new and improved ways of enhancing the potential of people. Technology alone, no matter how advanced, cannot solve the problems of Canadian industry.

Even the so-called "smart" technology can only succeed when it is adopted by an involved, well-prepared, and committed work force. Increasing numbers of Canadian companies are therefore adopting new organizational forms that marry the human and technological needs of the enterprise.

The actual forms that such innovations take are many and varied, as we shall see in the next section. They run the gamut from Japanese-style quality-control circles through employee involvement to gain-sharing plans to the so-called sociotechnical design of the world-famous Shell Canada plant in Sarnia, Ontario. Why, then, are organizational innovations receiving more attention, and what is their particular relationship to new technologies?

One obvious reason is that improving the quality of working life is a valid end in itself and one that pays off in terms of motivation and commitment. In this light, recent developments may simply be viewed as the normal application of good human resource practices. But now there's a special urgency that springs from crucial "bottom-line" considerations. For example, an overwhelming concern in recent years has been the slowdown in the rate of productivity growth in this country and in the United States. Analysts of the "productivity puzzle," having examined and exonerated such potential culprits as energy and material prices, capital, and labour, have recently come to pay much more attention to how the various factors of production are *organized*. In particular, there is growing recognition that improved productivity and quality performance – and hence global competitiveness – rely heavily on the adoption of flexible new technologies. And successful adoption of those technologies, with their attendant requirements for a flexible, versatile, and committed work force, depends upon more participative organizational designs that realize the potential, and reflect the needs, of all stakeholders.

In the next sections we discuss some of the forms that organizational innovation may take. We also discuss some of the expected outcomes – the pros and cons – because we feel it is necessary to look at these developments in a realistic light. It is important to realize, for example, that there is no unique solution that fits all organizations. Needs differ; what was right yesterday may be inappropriate today, and the motivations and viewpoints of the key players do not always coincide. So much is true. It is also true that one can learn from experience. Accordingly, we sketch some recent developments in workplace innovation in Canada and attempt to draw some conclusions. That discussion draws upon a historical overview of Canadian workplace innovations, the Working with Technology Survey,[1] and numerous case studies.

In addition, Canadian developments may usefully be viewed in the light of international experience, which has clearly been influential. In the 1960s, labour analysts studied the Swedish labour-market system with great fascination. Norwegian-style industrial democracy was attractive for a while, as were the organizational designs of Volvo and Saab-Scania. Then the pilgrims made their

way to West Germany for a glimpse of the Mitbestimmung or "codetermination" model in which major corporate decisions are made by boards of directors, with worker representation. More recently still, many thousands of North American managers and trade unionists have tramped through Japanese factories and endlessly debated quality-control circles and the lifetime employment system. While the practices of other countries cannot be imported wholesale, foreign developments may help us learn from experience and enrich our understanding of options.

The cases we describe in this chapter involve innovations in job design, decision making, and remuneration. But we also give special attention to new patterns of working time that accompany technological and organizational change and that are also changing the face of the modern workplace. Part-time work, telecommuting, job sharing, and work sharing are increasingly common, and there is a growing interest in reducing the standard work week. Such issues are addressed in the second half of this chapter.

Workplace Innovation

Forms of Workplace Innovation and Their Pros and Cons

Numerous terms are used to describe the various forms and aspects of organizational change. A long and prominent tradition of work humanization is associated with the quality-of-working-life (QWL) movement. More recently, the term "employee involvement," or EI, has been increasingly used. In either case, a central tenet is that when attention is paid not only to the physical and monetary but also to psychic rewards, then the worker, the organization, and society at large may benefit.

Two major ingredients are contained, to varying degrees, in all the different kinds of organizational innovation we consider. The first is some change in the design of jobs and the roles, tasks, responsibilities, and accountability of the individuals who perform them. For example, job enlargement and job rotation are schemes to expose workers to a wider variety of tasks, while job enrichment involves additional responsibilities. The second is some change in the institutions and processes of decision making. Sometimes referred to as worker participation in decision making, industrial democracy, or employee involvement, this approach is concerned with the opportunities afforded to labour to share in decisions concerning the process of production. As such, it covers a variety of forms, from the conventional adversarial approach to collective bargaining in North America to the system of worker-owned enterprises that exists, for example, in Yugoslavia.

One of the more fashionable organizational innovations of recent times – quality circles – clearly contains elements of both job redesign and worker participation. Developed by the Japanese, quality circles consist of small groups of employees and their supervisors who meet regularly to examine techniques to enhance productivity and quality, to seek approval for their implementation, and to monitor their performance.

Perhaps the ultimate embodiment of such principles is the sociotechnical-systems (STS) approach to organizational and technological design. Briefly, this approach involves the mutual accommodation of the technical and social (i.e., work force) needs of the organization in the change process. In this way, its proponents contend, the human and social sides of the enterprise will not only complement but enhance each other. A keystone of the STS approach is the semi-autonomous work group – a team having collective responsibility for a natural, whole unit of work. Such teams typically enjoy considerable independence in planning, integrating, executing, and monitoring the tasks within their work unit. As they mature, they may take on such support functions as maintenance, financial control, and personnel. Most workers in such groups do not have separate job assignments or classifications; ideally they are multiskilled and can perform all the tasks within the work unit.

Not unexpectedly, innovations of the kind we have described are often associated with innovative forms of compensation. For example, multiskilling may be rewarded with some form of pay-for-learning arrangement in which workers are rewarded for the number of tasks they master. More common is some form of gain-sharing arrangement in which employees may receive a share of company profits, a bonus based on productivity improvements, or part of the cost savings to which they have contributed.

Thus the forms of organizational innovation are many and varied. So, too, are the views about how well it works. A Scandinavian expert recently remarked that the vast majority of people who visited the Volvo plant did so to convince themselves it could not work in their own countries.[2] But the doubts stem not only from the difficulties of transporting social and technical systems across national boundaries; there are other pros and cons as well. For example, it is argued that employee involvement is good for productivity because it systematically taps the experience and expertise of the work force. Workers may be more committed to decisions in which they have participated, and they may acquire information that helps them function more effectively.

To the extent that involvement fosters understanding and cooperativeness, it might even reduce costly grievances and disputes.

Critics argue that many workers simply lack either the interest or the expertise to make useful contributions to management decisions, especially in areas like finance. Next, the institutional machinery may be too unwieldy to reach the fast, timely decisions that are the essence of good management. Indeed, while for some people industrial democracy is an important recognition of the equal importance of labour and capital, others (including shareholders, perhaps) might argue that for management to share its authority is to abdicate its responsibility. Understandably, many managers themselves jealously guard traditional rights and prerogatives. At the same time, of course, the very reasons why management might be hostile to employee involvement could also account for the resistance of unions. Historically, trade unions have attempted to offset the inequitable exercising of managerial authority. When such authority is eroded, so is the union's raison d'être.

Furthermore, old suspicions die hard. For example, it is contended that institutional arrangements for joint decision making provide workers an opportunity to contribute expertise and to assert their interests. For some, however, such involvement is just another management ploy to achieve greater productivity – just another form of exploitation. Trade unionists may be concerned that such schemes are a means of "co-opting" workers to the management team.

These pros and cons are discussed merely in order to sound a cautionary note. There is no unique organizational panacea. The approach of one company or union may not be suitable elsewhere, so arrangements must always be customized. Nevertheless, our evidence suggests that Canadian organizations are implementing new working arrangements in increasing numbers and in various guises. In many situations, such organizational changes have been seen as a necessary concomitant of technological change. In the next section we review some recent developments in Canada.

Workplace Innovations in Canada

A background study prepared for the Council traces the emergence of workplace innovations in this country in recent years.[3] Prior to 1975 most such initiatives were aimed at the goals of work humanization and productivity improvement. While each is a legitimate goal in itself, managers came to view them as a causal chain, with motivation as the middle link. Innovations in this period took two basic forms: job redesign, and improvements in communications.

Examples of the former include the job-rotation scheme for production workers that was introduced in 1973 at Domtar's corrugated container plant in Toronto. Results included a more skilled, flexible, and less fatigued work force, as well as significant productivity improvements. Elements of both job enlargement and job rotation were included in the assembly operations at National Cash Register in Waterloo, Ontario. Production of a complete assembly, using a variety of tools and tasks (as opposed to the repetitive performance of a single task with a few components or subassembly), was designed to involve more autonomy and responsibility for pacing, hours, and tool selection. Improvements in both quality control and worker satisfaction are claimed by management.

Where the work involves a series of tasks to service a particular client or group, as in financial institutions, insurance companies, and service industries, efforts have been made to give employees the opportunity and the training to tackle the more responsible and complex tasks in the overall "service package." For example, between 1973 and 1977 the Prudential Insurance Company redesigned a dozen sections of its Toronto operations so that workers could be trained to handle a complete job, from paperwork to direct contact with clients. The changes yielded a variety of improvements, including expanded opportunities for advancement, better morale, and lower turnover and training costs.

Efforts to improve communications and information frequently involved some sort of joint-committee structure of management representatives and workers or their unions. In the early 1970s, after long periods of industrial unrest, both Ontario Hydro and Inco established such committees to improve morale and to provide a less adversarial forum for the airing of concerns. Claims that they enhance mutual understanding, which is reflected in less troublesome negotiations, smoother resolution of grievances, and a lower incidence of strikes, have done much to popularize such committees. By the late 1970s the federal government and the governments of Alberta, New Brunswick, and Ontario had established formal programs to encourage the creation of various levels of joint committees in their respective jurisdictions.

Since 1975 two major forms of workplace innovation have emerged. The first is an outgrowth of the earlier joint-committee initiatives that, in addition to regular information exchange, is also concerned with immediate working conditions, productivity, quality, and health and safety. Such initiatives are generally an adjunct to the existing structure of the organization and in the case of unionized settings are an arrangement that should not interfere with traditional collective bargaining. Quality circles are an example of such schemes, as are EI and QWL programs.

A successful example of this approach was initiated by the American Cyanamid Company and the Energy and Chemical Workers' Union Local 21 at the plant in Welland, Ontario, in 1980. The company and the union jointly developed a QWL program based on a four-level system of committees for information exchange and participative decision making. They established a *steering committee* consisting of local and corporate-management representatives, and local and national union representatives; a *plantwide committee* with representatives from plant management, the union, foremen, and workers; *business teams* from all interests and functions within a department; and *shift teams* composed of a foreman and hourly workers from one shift. The business teams and shift teams started up in the two pilot departments early in 1983. By year's end the company could point to savings of $372,000 as a result of lower turnover, fewer grievances, less downtime, better productivity, and 130 employee suggestions for efficiency improvements.

Such participative ventures are attractive to management as a way of gaining support for technological change and also to governments anxious to improve the labour relations climate. Importantly, they are enjoying increasing support from unionists. Not surprisingly, therefore, they are by far the most common approach to organizational innovation in Canada today. The weight of experience with quality circles and EI programs strongly suggests that given the opportunity to participate, employees are committed to productivity and quality. In 1985, IBM Canada boasted some 800 quality circles among its 11,000 employees. Its 1,400-strong administrative group alone participated in more than 170 teams and project groups, and developed about 1,900 suggestions for improvements.[4]

The very success of participative forms of organization has led, in some cases, to formal arrangements for sharing the benefits of that success. *Gain-sharing* or *productivity-sharing* programs, such as the Scanlon Plan or Improshare, are examples of such remuneration schemes. Unlike *profit-sharing plans* (which some trade unionists say are too easily manipulated by management), these schemes distribute a share of the cost savings and/or productivity improvements generated by the workers themselves. The Scanlon Plan, introduced by Hayes-Dana and the International Association of Machinists and Aerospace Workers in St. Thomas, Ontario, in 1969, has shown significant increases in productivity and associated increases in employee earnings, lower turnover and absenteeism, and improved industrial relations.

The second major form of organizational innovation to emerge in Canada in recent years is the sociotechnical-systems approach described briefly earlier. This is undoubtedly the most fundamental, radical, thoroughgoing approach, inasmuch as it emphasizes the notion of change as a continuous process. Organizations must continually adapt to a complex and constantly changing environment; work groups must deal with new problems and develop new roles and relationships as the needs and resources of the organization change; and individuals must learn new skills and readapt themselves to the group and to the organization. The key elements are, therefore, the flexibility and adaptability that come from *continuous learning*.

This emphasis on continuous change and adaptation poses a major challenge to traditional management and union structures and requires a good deal of commitment and courage. Thus, while the STS approach is gaining greater attention in Canada as managers and the work force come to accept the need for more radical routes to organizational effectiveness, it is extremely difficult to implement in practice. Not surprisingly, it has been used most often in the design of new organizations (where, by definition, old habits and entrenched interests have not yet formed) and in non-union settings.[5]

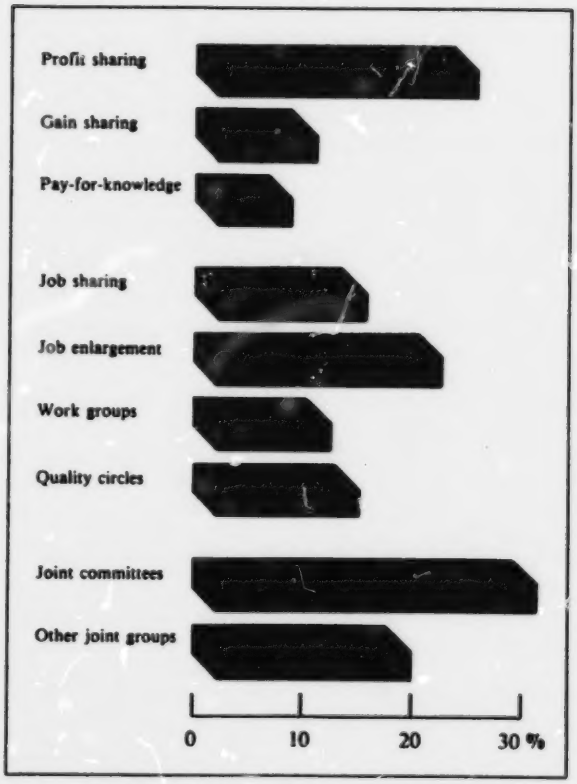
The approach lends itself especially to capital-intensive, highly integrated, continuous-process industries like chemicals and refining, where rapid high-quality responses to variances in the normal flow of production are necessary to avert enormous costs. The use of extremely complex and highly integrated advanced technologies is a major factor in the adoption of STS by Shell Canada, Eldorado Resources, Canadian General Electric, and Pratt and Whitney Canada. The approach, however, has also been used in batch and warehousing operations (Macmillan-Bloedel, Dominion Shoes), and in numerous office settings (such as Manulife, Westinghouse, and several federal public service sites). In Canada to date, however, the best-known application is the Shell Canada chemical plant in Sarnia, Ontario, where the company and the Energy and Chemical Workers' Union Local 800 jointly implemented an STS design. The story is well documented[6] and will not be repeated here. Suffice it to say that the joint company/union analysis of performance in 1983-84 yielded impressive results in terms of human resource utilization and development, quality control (handled entirely by operating personnel), productivity, absenteeism, downtime, and grievances.

How commonplace have the various organizational innovations described here become within Canadian industry? Recent information comes from the Working with Technology Survey. Some 65 per cent of the establishments surveyed reported some form of organizational innovation during the period 1980-85. Chart 7-1 shows that three main forms of organizational change were distinguished in the survey: innovations in remu-

neration (such as gain-sharing), changes in the organization of work (such as quality circles) and joint decision-making arrangements (such as labour/management committees). Most common are decision-making arrangements. Nearly 30 per cent of the respondents, for example, reported joint labour/management committees. There is evidence, however, that these committees have not been used extensively in the process of planning that precedes the introduction of new technologies. As described in Chapter 6, while management (overwhelmingly) and even consultants and vendors were prominently represented in the planning process, the involvement of worker groups and labour/management committees was less frequently reported.

Chart 7-1

Distribution of Establishments with Organizational Innovations, by Type, Canada, 1985



SOURCE Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

Despite the attention directed toward work-organization innovations in recent years, our research suggests that most Canadian establishments continue to organize production according to relatively traditional practices. Schemes to redesign jobs through enlargement, rotation, and enrichment were practised by fewer than one-quarter of the survey respondents, while just 13 per cent had imported the Japanese quality circles. Job sharing, an organizational innovation that has received popular attention as a way of accommodating individual preferences for less-than-full-time work, was also infrequently reported. There is evidence of innovative compensation arrangements in the form of profit-sharing, gain-sharing, or pay-for-knowledge; but, again, these appear to have been implemented by a relatively small minority of firms in this country.

The value of various forms of organizational innovation is being recognized by increasing numbers of Canadian establishments; indeed, as the preceding discussion suggests, there are successful examples of new working arrangements. On balance, however, it appears that most establishments in this country are operating according to traditional principles of work design and decision making.

Macro-Level Developments

The developments we have described relate primarily to the level of the organization. For shop-floor innovations to flourish, however, they must ultimately be consonant with union/management/government relations at the societal level. In recent years a number of multipartite "consultative mechanisms" at the national, provincial, and sectoral levels have shown that die-hard traditions of suspicion and mistrust can be overcome when concerned parties jointly address clearly defined major issues of mutual concern. Important examples include the Tier I and Tier II consultations based on a task-force approach to the examination of 23 industry sectors in 1977-78. Initiated by the Department of Industry, Trade and Commerce, the Tier I exercise included extensive consultations, analysis of industry-sector profiles, and federal-provincial discussions, and it concluded when the various sector task forces developed conclusions and recommendations. Thereafter, the Canadian Labour Congress and the Business Council on National Issues struck a bilateral 10-person Tier II Committee, with equal representation from business and labour. It distilled the 23 sector reports into a synthesis statement that contained conclusions and recommendations relating to a variety of common issues, including international trade developments, R&D, energy, and regional development.

Important lessons learned from the Tier II experience were carried over into the Major Projects Task Force of 1979-81: parity for labour in the executive and representational functions of the task force; autonomy to determine the agenda and working procedures; a staff accountable to the task force; and no imposed deadline.[7] The task force, co-chaired by Robert Blair, CEO of the Nova Corporation and Shirley Carr, then executive vice-president of the CLC, produced numerous recommendations aimed at maximizing Canadian benefits from anticipated megaprojects in the resource sector.

Though they did not focus specifically on the main subjects of our present concern, these initiatives represent important consultative mechanisms that might well be considered for the development of policies and programs relating to technological and organizational change.

Other higher-level initiatives directly related to innovation include the establishment of the Canadian Labour Market and Productivity Centre (CLMPC) in 1984. Funded by government, it has a bipartite structure based on equal representation of labour and business. Its objectives include a quest for consensus on means to improve the functioning of labour markets and to enhance growth in productivity and employment. In principle, at least, the Centre's mandate provides the opportunity to forge links between workplace innovations and broader societal changes, since its objectives include "a planned, orderly, and participative process of adjustment to new industrial structures and to changing methods and technologies" and "greater opportunity for individual self-realization through increased access to meaningful training, education and employment."[8]

In Ontario, in 1983-84, the senior-level tripartite QWL Advising Committee changed its focus of attention away from shop-floor, workplace changes and more toward concern for macro-level issues like the future of industrial relations in Ontario and the competitive viability of Ontario industry. The change in emphasis was reflected in its name change to the Ontario Labour Management Study Group. Quebec's multipartite Beaudry Commission, set up in 1984, is another example of a more macro-level attempt to explore the possibilities of instituting less adversarial labour-relations procedures. And the province of Manitoba recently set up a Workplace Innovation Centre concerned with productivity and innovative approaches to workplace issues, focusing especially on new technologies.

Some International Perspectives

It is clear that however powerful the motives for technological and organizational change at the level of the enterprise, such changes do not occur in a vacuum. Broader environmental factors are also at work: social, political, and market forces may encourage or impede local initiatives. The institutional framework of industrial relations, the education and training system, the legal framework – and, some claim, the very culture of the people – all affect the chances of successful organizational innovation.

This section is not designed to suggest that Canadians should effect a wholesale transfer of foreign approaches to employee involvement and workplace design. We must develop and adapt our own approaches. Nor do we suggest that countries like Norway, Sweden, and West Germany are paragons of labour-market virtue; they have their problems too, of course. But what is instructive about the experience of such countries is simply that the issues of organizational change, technological change, employee involvement, and work redesign are widely recognized as component parts of organizational and national effectiveness. More specifically, such issues have a much higher profile in public debate, on the national political agenda, and in social science research. They are the explicit focus of collaborative efforts among national-level union and employer confederations, research institutions, and governments. And in such countries they have been the subject of legislative reform. It may be argued, therefore, that shop-floor innovation has a greater chance of success in such a climate.

Norway has played a prominent part in the development of the theory and practice of organizational innovation. It was there, in the early 1960s, that it was decided to develop further some of the experiences from British coal mining that had received a lot of attention from researchers of the famous Tavistock Institute of Human Relations in London. The Norwegian Industrial Democracy Program saw the establishment of a number of field experiments in various industries that explicitly incorporated principles of organization redesign and participative decision making.

After some setbacks in the early 1970s, such developments regained momentum with the aid of important national-level initiatives. The first is the incorporation of certain principles of organizational design and participative decision-making in the *Work Environment Act* of 1977. The legislation is primarily concerned with health and safety issues; however, certain clauses from paragraph 12 of the Act are instructive. Consider clause 2:

Arrangement of work

> The individual employee's opportunity for self-determination and professional responsibility shall be taken into consideration when planning and arranging the work. . . . Efforts shall be made to avoid undiversified, repetitive work and work that is governed by machine or conveyor belt in such a manner that the employees themselves are prevented from varying the speed of work. Otherwise efforts shall be made to arrange the work so as to provide possibilities for variation and for contact with others, for connection between individual job assignments, and for employees to keep themselves informed about production requirements and results.

The principle of employee involvement is embedded in clause 3:

Control and planning systems

> The employees and their elected union representatives shall be kept informed about systems employed for planning and effecting the work, and about planned changes in such systems. They shall be given the training necessary to enable them to learn these systems, and they shall take part in planning them.

Under the aegis of such provisions, along with a national agreement on workplace development between the Federation of Trade Unions and the Employers' Confederation in 1982, and with the active and very pragmatic involvement of the Work Research Institute in Oslo, Norwegian workplace innovations are flourishing.

Sweden, too, has attracted the attention of the world because of its developments in organizational design. Starting with the growing concern amongst Swedish production engineers in the 1960s that traditional forms of work organization were no longer appropriate, several initiatives were followed. The major national economic partners established a joint council to oversee a broad program of examination of organizational design issues. Joint committees were established to initiate workplace democratization within the public service and state-owned enterprises.

Despite the extremely strong centralist tradition in Swedish labour market administration, however, a major role in organizational innovation was, and is, management-initiated – Volvo Kalmar being the best example. Perhaps in response to this, the Swedish trade unions recently moved to establish greater influence in such developments. In 1982 the Federation of Trade Unions, the Federation of Salaried Employees' Unions, and the Employers' Confederation reached a national agreement on workplace and enterprise development.

The West German approach to industrial democracy enshrined in Mitbestimmung, or the codetermination of major corporate decisions by labour/management boards, is well-known and will not be described here. Suffice it to say that throughout western Europe the conviction about the effectiveness of workplace innovations is backed by national legislation, national-level agreements among the major economic partners, and elaborate programs of research, experimentation, consultation, and implementation by government-supported work research institutes.

In European countries of both the East and the West, there are common concerns about global competitiveness, productivity, costs, and quality. There is a shared conviction that adoption of the new technologies is the key to achievement of those goals. And there is broad agreement that the design of appropriate work organizations is crucial for the acceptance of, and fullest exploitation of, the new technologies. The East Germans, the Poles, the Hungarians, the Czechs, and the Bulgarians are united with their western European neighbours in the belief that the so-called scientific management principles founded by Frederick Taylor are outmoded and dysfunctional for present-day industry and its technological future.[9] Machine-paced work, highly fragmented, specialized tasks, and rigidly hierarchical organization structures are almost universally recognized as counterproductive in settings where the new technologies call for commitment; interdependence; group problem-solving; and, above all, flexibility.

The major lesson from Europe is that in most countries, unlike Canada, there is a national-level social concern about the organizational implications of new technologies – concern that is expressed in the research priorities of social sciences, in government commitment to national work-research institutes, in national agreements among major economic partners, and in legislation. In Canada there seems to be an imbalance. Much rhetoric is expended on a national science-and-technology strategy, and on the adequacy of our R&D commitment. But although QWL has, at certain times and in certain places, figured on the political agenda, there seems to be little public awareness of, and even less commitment to, the concept of organizational innovation.

One crucial aspect of work organization that *is* receiving increasing public attention, both in this country and abroad, is working hours. A variety of social forces, combined with technological and organizational innovation, are producing profound changes in the patterns of working time. The 9-to-5, 2,000-hour year is already a thing of the past for many Canadians. Flexitime, job sharing, and part-time work are increasingly common,

while reduced working hours are seen by some as a way to enjoy the fruits of technological change and by others as a way to lessen its disemployment effects. Such questions are the subject of the next section.

Alternative Work-Time Arrangements

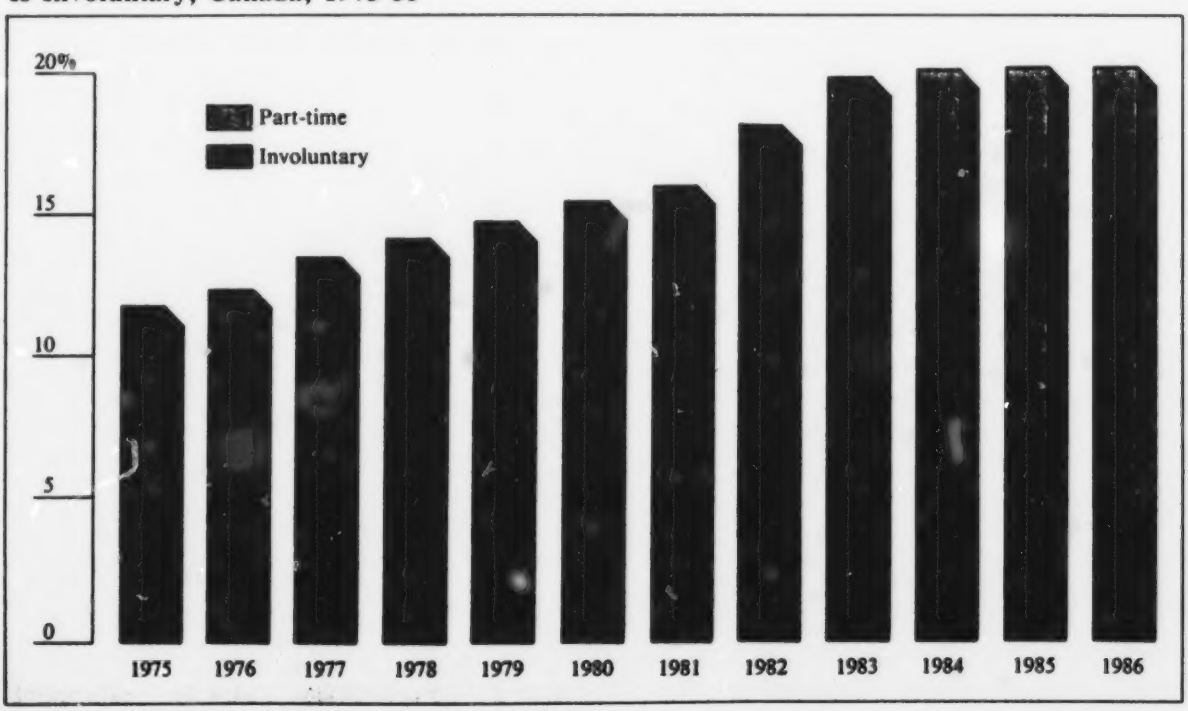
The nature of productive activity has always affected the rhythm and intensity of work. The dawn-to-dusk, unrelenting toil of spring planting and harvest time, the shift work and overtime requirements of the factory, and the infrequent but intensely concentrated efforts of the rock star or the professional golfer are all examples of such determinism. Now, changes in technology, in organization structure, and in the design of jobs are altering hours of work considerably.

The increasing emphasis upon global competitiveness and the drive for industrial rationalization have led many employers to seek cost reductions through increased emphasis on part-time work. Technological and organizational changes are frequently adopted to aid such pursuit of cost reduction and productivity. In addition, innovation may affect working time in other ways. For example, the justification for heavy expenditures on advanced capital equipment may involve intensive utilization, and thus the use of shifts. And advances in communications technology permit increasing numbers of people to spend more of their working hours at home by "telecommuting."

To these trends must be added an important social impetus for new arrangements of working time. Along with the growing number of working women comes an increasing need for part-time jobs to accommodate family demands. Indeed, changing attitudes within families are leading to some increase in demands for flexible arrangements from men too. As greater numbers of young people pursue postsecondary education, there is a rising demand for opportunities to supplement income while attending school part-time, while at the other end of the age spectrum the "greying" of

Chart 7-2

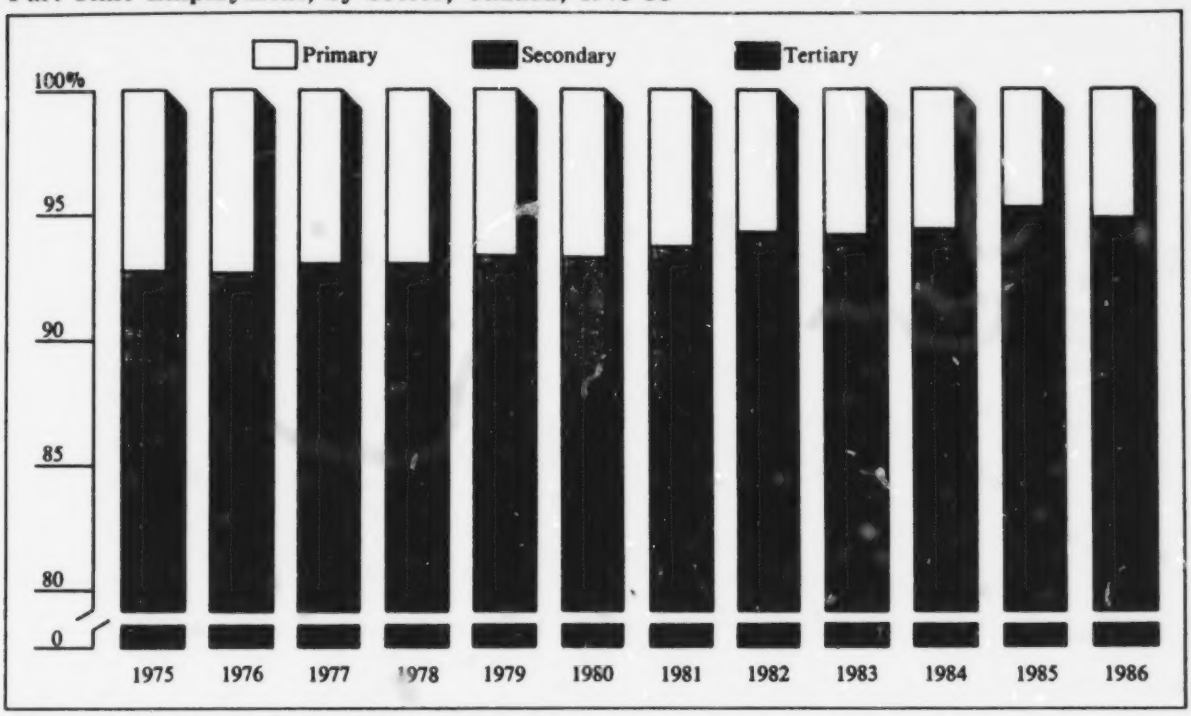
Part-Time as a Proportion of Total Employment, Indicating Portion Which Is Involuntary, Canada, 1975-86



SOURCE Based on data from Statistics Canada, Labour Force Survey.

Chart 7-3

Part-Time Employment, by Sector, Canada, 1975-86



SOURCE Based on data from Statistics Canada, Labour Force Survey.

the work force has led to demands for phased and early-retirement schemes. Next, demands for a general reduction of working time reflects both a growing preference for leisure and, at the same time, a search for ways to alleviate the unemployment problem. Finally, work-humanization trends have included greater worker discretion in the determination of work hours.

What must be clearly understood, however, is that not all of the developments we describe are an unmixed blessing. For some workers, part-time employment represents a welcome opportunity to supplement family earnings or to enjoy more leisure. For far too many, however, it means low incomes, poor benefits, and inferior working conditions. Even when the arrangements are voluntary, there are real costs involved: trade-offs must be made.

Types of Arrangements

Part-Time Employment

The growing incidence of part-time employment in this country is clearly shown in Chart 7-2. The lower portions of the columns, showing the involuntary component, suggest that much of the stimulus for this growth may stem from the employer's cost considerations rather than the convenience of employees, although the involuntary part-time share of total employment appears to have tailed off somewhat in the last couple of years. Notice also the sharp rise between 1981 and 1982, when the recession had taken hold. As far as the future is concerned, employers generally expect that part-time and full-time employment will increase at about the same rate.[10]

The industrial composition of part-time employment in Canada is shown in Chart 7-3. The tertiary (service) sector's share of part-time employment has been rising gradually since 1975, while the proportion accounted for by the primary and secondary sectors has fallen somewhat. Other data show that it is the community, business, and personal services industries that are responsible for much of the tertiary sector's increase. The occupational composition in Chart 7-4 reveals a similar story, in that white-collar occupations are gradually increasing their share of part-time employment. More detailed data from the Labour Force Survey reveal

that much of the growth is in the managerial and professional categories, as they increased their share from around 16 per cent in 1975 to over 20 per cent by 1986. Finally, our Working with Technology Survey found a larger proportion of part-time workers in non-innovating (16.8 per cent) than in innovating (12.7 per cent) establishments, presumably because the latter exhibited stronger output growth and thus a fuller utilization of their human resources.[11]

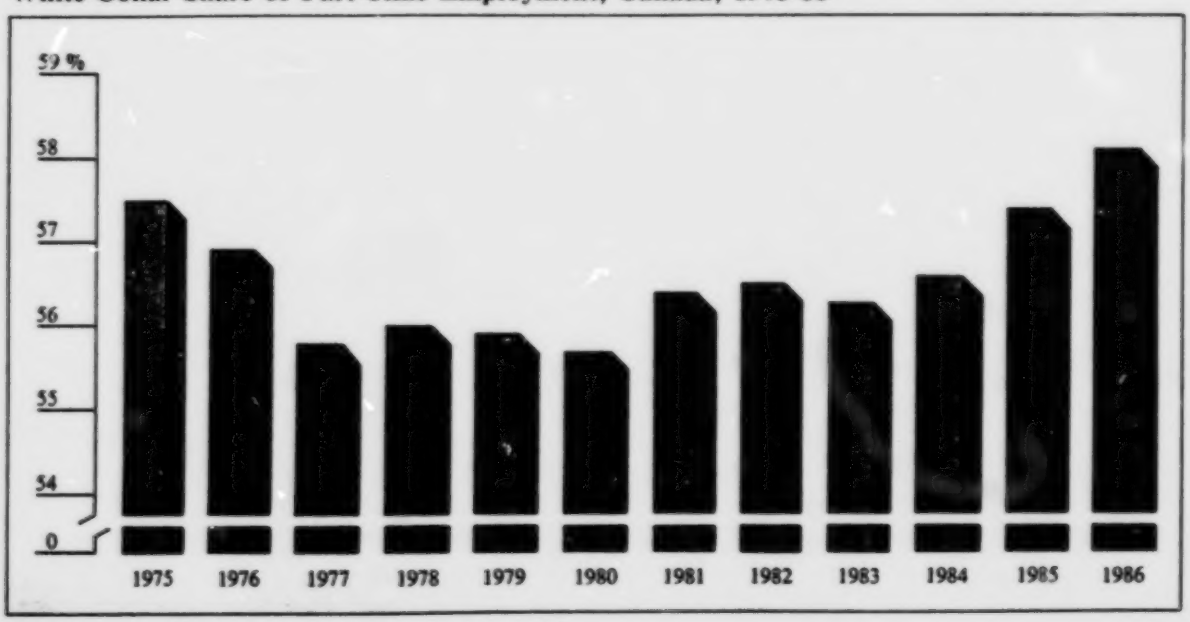
Traditionally, the definition of part-time employment has been based on the number of hours worked per week or month. Indeed, the preceding charts were based on Statistics Canada's definition of 30 hours or fewer per week. Labour Canada's Commission of Inquiry into Part-Time Work, however, recommended a more encompassing definition: "A part-time worker is one who works less than the normally scheduled weekly or monthly hours of work established for persons doing similar work."[12] This definition recognizes a number of different types of part-time workers: for example, "regular" or permanent part-time employees, who work less then normal weekly or monthly hours but have a continuing employer attachment throughout the year; and "casual" part-timers, including temporary employees, generally taken on to meet unscheduled peak workloads, and "seasonal" workers who work on a part- or full-time basis to meet seasonal peaks. Often, part-timers from the latter two groups work on a full-week basis and therefore would not be considered part-time by the traditional Statistics Canada definition. Table 7-1 shows that one-half of part-time workers are permanent – that is, they worked fewer than normal hours every week of the year – while the remainder are almost evenly split between seasonal and temporary part-timers. Seasonal part-timers are the best-paid, mainly because of their industrial concentration. Finally, there are also older part-time workers, gradually reducing hours until retirement, and job sharers – sometimes considered a type of part-time worker – who will be considered in a separate section.

We have already noted some advantages of part-time employment. It offers individuals who cannot, or prefer not to, work full-time the opportunity to earn an income and maintain some attachment to the labour force. For employers, the use of part-time employment can reduce costs and permit flexibility in scheduling and in responding to fluctuations in production.[13]

But there are drawbacks as well. For employers, the disadvantages in using part-time employment chiefly centre on the higher per-capita cost of supervising, hiring, and training the additional workers. From the worker perspective, part-time work often means poorer fringe-benefit coverage in such areas as medical and disability insurance, and pensions. Even in companies with very generous benefit packages, while coverage is virtually universal for full-time workers, most part-timers are excluded (Table 7-2). Furthermore, part-

Chart 7-4

White-Collar Share of Part-Time Employment, Canada, 1975-86



SOURCE Based on data from Statistics Canada, Labour Force Survey.

Table 7-1

Distribution of Part-Time Employment, by Type, and Hourly Wage Rates, Selected Companies,[1] Canada, 1984

	Distribution of part-time[2] employment	Hourly wage rate
	(Per cent)	(Dollars)
Permanent[3]	49.7	9.15
Seasonal[4]	23.4	10.20
Temporary/casual[5]	25.4	9.05
Total[6]	100.0	9.36

1 Based on a sample of 270 companies that supplied detailed information. These companies employed 69 per cent of those covered by the survey, who in turn represented 81 per cent of those in federally regulated companies.
2 Part-time employees are those working less than the number of hours normally scheduled in the employer's standard work week.
3 Employees who work fewer than full-time hours but who usually work a full number of weeks or months per year and are considered permanent or regular employees.
4 Employees who usually work fewer than 12 months per year and who may work part-time or full-time hours during their working weeks.
5 Employees who work on an occasional basis and usually for brief periods of time, ranging from a single day or less to several months (such as maternity leave replacements). Excluded are those paid by a placement agency under contract.
6 Totals include those classified "other" (i.e., those who do not fit any of the above three part-time categories); therefore the percentages do not add to 100.

Source: Labour Canada, *A Survey of Part-Time Employment in Federally Regulated Industries*, vol. 1 (Ottawa: Labour Canada, December 1985), p. 21.

Table 7-2

Benefit Coverage of Full-Time and Part-Time Employees, Selected Companies,[1] Canada, 1985

	Proportion of employees covered	
	Full-time[2]	Part-time[3]
	(Per cent)	
Type of benefit:		
Short-term disability	99	62
Long-term disability	99	30
Life insurance	99	29
Extended health	99	43
Dental	96	40
Pension	99	18

1 Those companies which supplied detailed information on benefit coverage.
2 Employees who regularly work the number of hours normally scheduled in the employer's standard work week.
3 Employees not considered as full-time.

Source: Labour Canada, *A Survey of Part-Time Employment in Federally Regulated Industries*, vol. 1 (Ottawa: Labour Canada, December 1985), p. 53.

timers are frequently paid less on an hourly rated basis than full-timers with equivalent jobs and seniority (Table 7-3).[14]

In addition to poorer pay and benefits, part-time workers tend to have not much job security and relatively few opportunities for training and career advancement.[15] Paradoxically, a large proportion of employers feel that part-time workers, particularly permanent ones, are at least as productive and as committed to their jobs as full-time workers (Table 7-4). In fact, it appears that costs and administration problems are the common reasons for limiting benefit plans to full-time workers.[16] Still, recent federal legislation and legislation that has already been in effect since 1984 in Manitoba now require that part-time employees be eligible for company-sponsored pension plans – a step in the right direction. In fact, there is evidence that some firms are already doing this.[17]

Finally, it should be pointed out that part-timers have relatively low propensities toward unionization; accordingly, unions have not traditionally welcomed the spread of part-time employment, particularly where it is involuntary. Moreover, because of the disadvantages to workers noted above, unions object to the use of part-time work when it is instituted at the expense of full-time employment.[18]

Job Sharing

Job sharing refers to voluntary arrangements whereby two workers share a job traditionally filled by one full-time worker. Unlike part-time work, job sharing is often found among higher-level professional jobs. Job-sharing arrangements typically provide for salaries and fringe benefits to be paid at the regular full-time rate.

Many of the advantages and disadvantages associated with part-time work also apply to job sharing.[19] On the whole, unions have been relatively supportive of job sharing, since it is usually established at the urging of the workers involved, with wages and benefits paid on a pro-rated basis. What they are primarily concerned about is the use of job sharing to avoid the spirit of the collective agreement or to reduce legitimate overtime.

As job sharing is a fairly recent phenomenon, scant information exists on the extent of its application. Moreover, Statistics Canada's Labour Force Survey does not distinguish job sharers from traditional part-timers. But there is some evidence of its existence from

Table 7-3

Pay Rates of Part-Timers[1] Compared with Those of Full-Timers Having Equivalent Jobs and Seniority,[2] Selected Companies,[3] Canada, 1985

	Proportion whose pay rates were:		
	Higher	Same	Lower
	(Per cent)		
Salaried part-timers			
Permanent[4]	9	76	16
Seasonal[5]	4	49	47
Temporary/casual[6]	2	66	32
Hourly part-timers			
Permanent[4]	3	65	32
Seasonal[5]	4	57	38
Temporary/casual[6]	2	65	43

1 Employees who regularly work less than the number of hours normally scheduled in the employer's work week.
2 Full-timers with equivalent jobs and seniority as part-timers.
3 Those companies in which the comparison was made between part-timers and full-timers having equivalent jobs and seniority.
4 Employees who work fewer than full-time hours but who usually work a full number of weeks or months per year and are considered permanent or regular employees.
5 Employees who usually work fewer than 12 months per year and who may work part-time or full-time hours during their working weeks.
6 Employees who work on an occasional basis and usually for brief periods of time, ranging from a single day or less to several months (such as maternity leave replacements). Excluded are those paid by a placement agency under contract.

SOURCE: Labour Canada, *A Survey of Part-Time Employment in Federally Regulated Industries*, vol. 1 (Ottawa: Labour Canada, December 1985), p. 43.

Table 7-4

Proportion of Employers Who Felt that Part-Timers, by Type, Were at Least as Good as Full-Timers in Certain Respects, Selected Companies,[1] Canada, 1985

	Type of part-timer[2]		
	Permanent[3]	Seasonal[4]	Casual/ temporary[5]
	(Per cent)		
With respect to:			
Productivity	80	71	71
Job commitment	84	66	68
Absenteeism	82	84	82
Turnover rates	69	51	42

1 The number of responses varied depending on type of part-timer and characteristic.
2 Employees who regularly work less than the number of hours normally scheduled in the employer's standard work week.
3 Employees who work fewer than full-time hours but who usually work a full number of weeks or months per year and are considered permanent or regular employees.
4 Employees who usually work fewer than 12 months per year and who may work part-time or full-time hours during their working weeks.
5 Employees who work on an occasional basis and usually for brief periods of time, ranging from a single day or less to several months (such as maternity leave replacements). Excluded are those paid by a placement agency under contract.

SOURCE: Labour Canada, *A Survey of Part-Time Employment in Federally Regulated Industries*, vol. 1 (Ottawa: Labour Canada, December 1985), pp. 36-8.

a national survey of job sharers conducted by the Commission of Enquiry into Part-Time Work. Although it was not intended to give an indication of the incidence of job sharing in Canada, the survey was able to provide a profile of the typical job sharer: a female from a two-earner family and a professional in the public service, with some postsecondary education. All respondent job sharers felt that the experiment was a success and that job sharing would continue to grow in Canada.[20]

There now appear to be some institutionalized job-sharing arrangements in Canada. For example, the Manitoba Civil Service Commission and the Manitoba Government Employees' Association signed a letter of intent in their 1982 collective agreement, calling for consultation on all proposed job-sharing arrangements. This appeared to be the first Canadian case in which "an employer or a union has systematically examined a job sharing experiment involving a significant number of employees."[21]

Another example of job sharing is from the private sector, where the London Life Insurance Company is one of very few companies that has formally instituted job sharing among its staff. As of Spring 1986, there are 40 employees occupying 20 positions, all of whom have been offered the benefits provided to regular full-time staff, including medical insurance and participation in the pension plan. The extra cost of providing such benefits has been minimal. According to the company's Human Resources director, job sharing is a viable option.[22]

Work Sharing

Work sharing is an institutional arrangement designed "to eliminate the need for a planned or immediate temporary layoff of all or a number of the firm's employees" resulting from a fall in demand or introduction of a new technology.[23] Thus it is quite unlike job sharing, which is used to create part-time opportunities for those who want them. Usually at the initiative of the employer, a work-sharing agreement is entered into between the company and the work force to reduce the hours of all workers by the amount

required to avoid individual layoffs. These arrangements tend to be for specific, usually short periods of time, to tide a firm and its workers over temporary difficulties. Generally associated with work sharing is a short-time compensation scheme, which makes up for a portion of workers' wages lost because of work sharing. The intention is to avoid situations in which the economic hardship created by economic recession or technological change is borne by only a portion of the work force.

Work sharing enables employers to retain skilled workers in difficult times, thus saving future recall and possible recruitment and training costs. It can also improve morale. For the workers, in addition to job and income-security benefits, work sharing averts the erosion of skills that accompanies unemployment. It may also be useful in providing time to prepare for eventual job adjustments. There are also societal benefits in terms of equity and avoidance of unemployment-related inefficiency costs.

Work sharing has its shortcomings: workers do receive less income than would have been the case had they not been placed on work sharing, even with short-time compensation. Moreover, the possibility of layoffs once the agreement is terminated remains. Work sharing also means that employers may have to contribute to various benefit plans, which would not have been necessary had they merely laid off the workers in the first place.

Unions seem ambivalent about work sharing. On the one hand, central congresses are opposed to the concept inasmuch as it takes the pressure off governments in regard to the unemployment issue.[24] They also object to the fact that work sharing disregards the principle of seniority; can institutionalize part-time work; and, in the end, may not prevent layoffs anyway. On the other hand, union locals, from their closer perspective, tend to be more open to work sharing, often seeing it as providing immediate relief from layoff and as a day off at almost full pay.

In this country, Employment and Immigration Canada administers a work-sharing program. Under its Work Sharing program, both employees and employers faced with layoff file a *joint* application to CEIC. An agreement is drawn up, specifying the duration of the arrangement, which may range from six to 26 weeks, with the possibility of a 12-week extension. Under the terms of the agreement, employees are paid unemployment insurance benefits for the time they are not working, without the usual two-week waiting period. If they are laid off after the agreement terminates, they are entitled to the full UI benefit – a characteristic unique to the Canadian Work Sharing program.

An interesting feature of this program is the Work Sharing/Training link, which funds employers' training of workers on their work-sharing days when equipment is idle anyway. The purpose of this program is to enable workers threatened by layoff as a result of technological change to upgrade their skills and to use the new technology. Unfortunately, the take-up of this link has been rather limited, probably because much of the training required to operate the new technologies must be of a longer duration than allowed for during the span of the work-sharing agreement. For this reason there are no data available on this initiative, although it is still being offered.

The Work Sharing program also applies to permanent job-loss situations arising out of technological and structural change. In these projects, representatives of labour and business, together, develop a plan to manage the training and placement of the affected workers in new jobs. The maximum duration of these arrangements has been set at 50 weeks, thus permitting workers sufficient time to upgrade their skills and to find a new job. Again, however, the demand for this program has been small.

On the whole, there appears to be a lot of support for the Work Sharing program among employers and employees, according to a survey of employer and worker program participants conducted for a CEIC evaluation of the program.[25] Looking at it from the government's point of view, the benefits of the program exceed the costs to society by a ratio of 1.4 to 1. In 1983, however, the average cost of the program was about 35 per cent more than the amount that would have been paid out in UI benefits alone under layoff. But if one takes into consideration the social cost of layoffs that has been saved by work sharing, then its incremental cost is probably much less. Finally, according to the CEIC evaluation, the program was successful in averting over three-quarters of the expected layoffs in 1983.

Utilization of the work-sharing program is shown in Table 7-5. The figures show a general decline in the take-up of the program since its inception in its present form in 1982. Rather than showing a growing dissatisfaction with this program, however, these figures may be simply reflecting the recovery from the recession of the early 1980s: the number of layoff situations – not the interest in work sharing – has been dwindling. Indeed, the Work Sharing program has been a qualified success, with the three recent bodies of inquiry – the Macdonald Commission,[26] the Nielsen Task Force,[27] and the Forget Commission[28] – all coming out in its favour, though with recommendations for minor modification.

Table 7-5

Performance and Cost of CEIC Work-Sharing Program, Canada, 1982-86

	Number of:			
	Agreements	Participants	Layoffs averted	Expenditures
				($ millions)
1982	8,780	202,037	87,000	83.2
1983	7,238	93,813	34,836	83.1
1984	4,141	56,378	22,215	32.4
1985	2,659	36,631	16,404	25.2
1986	2,784	35,121	14,923	21.7

SOURCE Employment and Immigration Canada, *Evaluation of the Work Sharing Program* (Ottawa: CEIC, March 1984), and unpublished data.

Remote Working

Another alternative work arrangement is remote work, variously referred to as telework, home work, or out-work – the production of goods and services away from the traditional place of work, on an employed or self-employed basis. While it has a long history – through the "putting-out" system of early industrialism, for example – work from the home has lately attracted increasing attention. One contributing factor has been the growing interest in worker autonomy over hours and pace, which home working often provides.[29] Moreover, advances in communications and microelectronics technology clearly have been an important development, permitting computer links to headquarters. Still, the experience of remote work has been limited to a few ad hoc examples.

Telecommuting – "the substitution of telecommunications for physical travel to work"[30] – comes in many forms. These range from the informal home use of a personal computer by employees to catch up on work after hours, through to formal, full-time, work-at-home arrangements. We are now seeing remote workers in such computer-based occupations as data entry, word processing, computer programming, and reservations and billing – often in service industries such as finance, insurance, and real estate and in transportation and communications. Technology has not only allowed a greater amount of work to be done at home, but it has permitted possibilities that range quite far afield: sophisticated satellite technology has enabled some large multinational companies to rely on cheap offshore labour in developing countries to carry out routine data-processing operations.[31]

While home working offers personal flexibility and convenience, telecommuters' gains do not come without cost. For one thing, home workers are often paid on a piece-work basis; thus they may not receive compensation for overhead expenses or set-up time. They frequently do not receive the usual benefits; nor do they enjoy social contact with their colleagues and superiors – diminishing, in the latter case, their prospects of promotion. Finally, there are concerns, often expressed by unions, that home working undermines full-time work, stimulates the spread of contracting-out, and ultimately erodes the protection and benefits that workers should expect.

Reduced Work Time in General

All of the arrangements we have discussed are inextricably tied in with the broader issue of reduced work time. There are a number of other innovations associated with work-time reduction – such as leave for education, training and retraining, and sabbaticals; increased vacation time; and shortened work lives through early retirement and shortening the work week – that we shall consider in this section.

First, in examining Labour Canada's major collective-agreement file, it appears that educational leave and early retirement are becoming increasingly popular, as a growing proportion of agreements contain provisions for such arrangements (Table 7-6). On the other hand, the incidence of sabbatical-leave clauses has remained fairly constant since 1979. Looking at another version of work-time reduction, the length-of-service requirement for paid vacation leave has been falling, while the number of employees who could potentially qualify for annual vacation leave of six weeks' duration has been increasing.[32] A final way to reduce work time, which we shall look at, is to reduce weekly hours by cutting the standard work week;[33] as Chart 7-5 shows, this has exhibited only negligible change since 1973.

So the fundamental question is: Do workers *want* fewer weekly hours? The Conference Board of Canada recently tested Canadian attitudes to alternative working hours using a supplemental question on the Labour Force Survey.[34] That survey found that most Canadians would like a change in their working hours – some even showed a preference for more hours! But it also found that the majority would *not* take a pay cut or forgo future income for a cut in hours. Of the proportion (one-third) who would take a wage cut proportional to a cut in hours, most would take it in the form of a reduced work week rather than more weeks off per year or early retirement. Among the reasons given for reducing time, most cited the desire to spend more time with their families or in leisure pursuits. Understandably, those who could most afford it were most interested in taking hour or pay cuts. Therefore, females in two-

Table 7-6

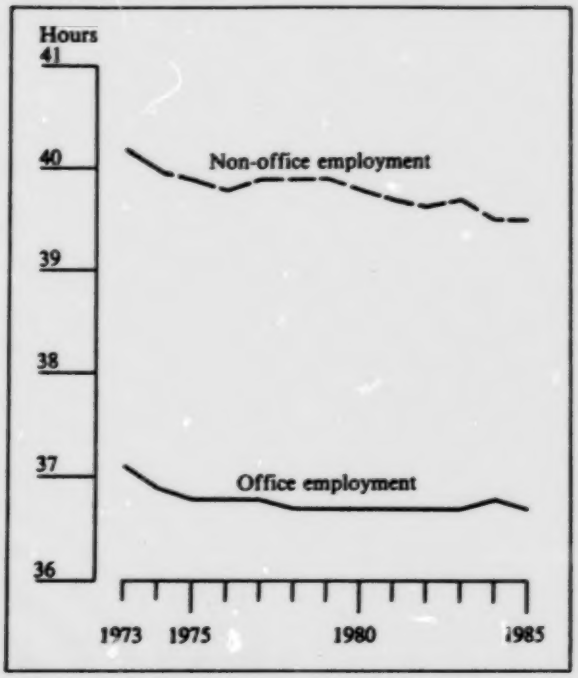
Proportion of Major Collective Agreements[1] Containing Provisions for Alternative Work-Time Arrangements, Canada, 1972-85

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
								(Per cent)						
Education leave:														
- paid	8.0	9.6	12.5	17.2	20.2	21.2	21.2	19.3	20.8	20.9	20.7	21.4	22.8	23.0
- unpaid or other[2]	..	..	..	..	..	..	..	18.3	19.6	21.9	22.7	24.0	24.5	25.4
Paid sabbatical leave[3]	..	..	..	..	..	..	..	7.1	7.2	7.4	7.3	7.8	7.8	7.6
Early retirement benefits[3]	..	..	..	..	..	..	..	13.4	17.4	19.6	20.7	21.9	25.6	29.1

1 Agreements covering 500 or more employees. Construction is excluded after 1978.
2 "Other" includes educational leave provisions that did not specify whether or not leave was paid; coded only since 1979.
3 Coded only since 1979.
SOURCE Based on data from Labour Canada, Collective Bargaining Division.

Chart 7-5

Average Weekly Standard Hours of Work, Canada, 1973-85



SOURCE Labour Canada, *Wages and Working Conditions*, various years.

earner families and single or divorced males were interested, as were workers who were prime-aged, full-time, highly skilled or professional/managerial, and highly educated. It is interesting to note that this desire for fewer hours would not necessarily translate into a proportional increase in employment, because several respondents indicated that in their time off they would do the work they would normally have others do for them or they would work at a second job.

The employment implications of reduced work time are an important issue of public debate in this country and abroad. The issue, however, is by no means clear-cut.[35] For one thing, reduced standard hours may lead to productivity increases that offset the employment-creating impact of an hours reduction (especially if the reduction is small). This can take place directly by rationalizing time use and by reducing the inherent slack in the system, where workers shift their on-the-job leisure off the job, or by inducing employees to work harder.[36] Paradoxically, reduced standard weekly hours might even lead to employment reduction, but by a rather indirect route. If overtime at premium rates leads to increased labour costs, firms may be induced to invest in labour-saving machinery and equipment.

Nor might work-time reductions lead to increases in employment in situations where firms are unable to find suitably skilled workers to fill the gap created by the shortening of hours: the skills of the unemployed may not match those of the newly created job vacancies. Moreover, firms may find the added expense of hiring and training additional workers too much to bear, especially if they are smaller enterprises. Finally, the effect on labour supply must also be taken into consideration. If the hourly wage rate were raised in order to offset the hours reduction and to maintain workers' earnings, it is likely that additional workers would be drawn into the labour market, thus tending to increase unemployment and negate the expected positive impact of an hours reduction.

This leads us to the thorny question of whether incomes should be shared in the event of working-time reductions. Employers point out that if incomes are not shared – and hourly pay rates rise – their competitiveness, and hence their ability to hire additional workers, will be impaired. Labour, on the other hand, argues that technological change has greatly increased productivity, which should provide the key to financing shorter working time.[37]

Clearly, the impact of reduced hours is difficult to resolve from a macroeconomic point of view, since the measure touches on several areas of economic performance, including inflation and the trade balance. To get some feel for these issues, we have carried out hours-reduction simulations on two macro models.

First, we used the Council's CANDIDE model to simulate a reduction in the work week by one hour, making various assumptions about inflationary expectations and productivity. As we suggested, work-week reduction will have an impact on several facets of the economy, especially if the wage rate is increased to compensate workers for the loss in work hours. Indeed, as Table 7-7 indicates, cutting the standard work week by one hour[38] (a 3 per cent reduction) with no adjustment to average hourly wages and person-hour productivity (simulation H1) will increase employment, compared with the "control" solution, but by less than 3 per cent because of overtime leakage. Also, because increased job opportunities attract additional workers into the work force, unemployment improves even less. This leads to sharp increases in wages and prices, reduced productivity and real incomes, and a worsening of the trade balance.

Table 7-7

Simulation (CANDIDE) of Net Impact on Major Economic Indicators of a One-Hour Reduction in the Work Week, Canada, 1987-95

	Difference			
	1987	1990	1993	1995
		(Per cent)		
Real GNP				
- H1 vs. control	-1.4	-1.0	-1.7	-2.1
- H2 vs. control	-1.2	-0.8	-1.2	-1.4
- H3 vs. control	-0.8	-0.2	-0.4	-0.5
Employment				
- H1 vs. control	2.7	2.4	2.2	2.0
- H2 vs. control	2.7	2.7	2.8	2.8
- H3 vs. control	2.7	3.1	3.3	3.5
		(Percentage points)		
Growth in productivity (Output per person-hour)				
- H1 vs. control	-0.7	-0.1	0.1	-0.2
- H2 vs. control	-0.5	-0.2	-0.1	-0.1
- H3 vs. control	-0.5	-0.1	-0.1	-0.1
Unemployment rate				
- H1 vs. control	-1.9	-1.4	-1.2	-1.1
- H2 vs. control	-1.9	-1.6	-1.6	-1.6
- H3 vs. control	-1.9	-1.8	-1.9	-2.0
		(Per cent)		
Consumer price index				
- H1 vs. control	2.1	3.2	6.1	8.7
- H2 vs. control	1.6	1.9	3.3	4.6
- H3 vs. control	1.0	1.2	2.7	4.4
Real hourly wage rate				
- H1 vs. control	-0.77	0.15	0.77	1.04
- H2 vs. control	-1.03	-0.25	-0.45	-0.53
- H3 vs. control	-0.49	0.50	0.46	0.34
Wage bill				
- H1 vs. control	1.0	3.0	6.0	8.0
- H2 vs. control	0.0	1.0	2.0	4.0
- H3 vs. control	0.0	2.0	3.0	5.0
		($ millions)		
Current-account balance				
- H1 vs. control	-3	-4,213	-6,474	-9,686
- H2 vs. control	-305	-3,715	-5,909	-7,999
- H3 vs. control	-1,301	-4,001	-7,056	-9,978
Federal government deficit				
- H1 vs. control	-384.5	-877.9	-1,135.4	-726.5
- H2 vs. control	-9.9	-388.2	-763.5	-981.8
- H3 vs. control	221.8	173.4	546.5	1,073.4

H1 - Control (base-case) solution but with an across-the-board, one-hour reduction in the work week in all sectors.
H2 - H1 solution but with wage moderation (inflationary expectations held fixed).
H3 - H2 solution but with an across-the-board increase in total factor productivity of 1 per cent.
SOURCE CANDIDE 3.0 simulations.

On the other hand, removing the wage/price connection by holding inflationary expectations fixed at control levels (H2) achieves better results. Not only is there a larger increase in employment and a greater drop in the unemployment rate than in the previous simulation, but output increases; the wage bill falls; and the deterioration in real GNP, as well as inflation and the current-account balance, is significantly reduced. When we further assume that technological change will contribute to an increase in total factor productivity of 1 per cent, while still holding inflationary expectations constant, most of the major indicators show even greater improvement (H3) versus the previous simulation (H2). Employment gains are larger; the rate of unemployment is lower; the government-deficit position is improved; and prices do not rise as much. The only bad news is that the current-account balance worsens by an even greater amount.

As can be seen, then, reducing the work week appears to increase employment, with the increases being even greater if we assume that technological change causes an increase in productivity and if wages do not respond to prices.[39] In other words, this simulation demonstrates that undergoing immediate pay cuts with hour cuts can lead to overall increases in income in the long run. But, would Canada be prepared to accept the deterioration in international competitiveness that would come as a result? Another tenuous assumption is the high degree of substitutability between the skills of the available unemployed and the currently employed. This would point to the need for increased training in order to prepare the unemployed for the jobs that might open up as a result of an hours reduction.

Another simulation was carried out, using MESIM – the Microelectronic Simulation model – which, as the reader will recall from Chapter 4, is able to measure the displacement caused by microelectronic-based technological change. Presented in Table 7-8 are the results of a MESIM exercise in which there was a reduction in the standard work week of 5 per cent – roughly a two-hour decrease in weekly working hours. The results show, first, that there are *potentially* greater numbers of people displaced by technological change when hours are reduced than when they are not, simply because there are more people in the labour force; however, as a proportion of the labour force, the displacement is the same. Moreover, when the impact of the increased demand arising out of the productivity increases from technological change is taken into consideration, we end up with increased employment, and thus a fall in the rate of unemployment of almost 3 percentage points.

Table 7-8

Simulation[1] (MESIM) of a Projected 5-Per-Cent Reduction in the Work Week, Canada, 1995

	Path:		
	Reference[2]	Reference post-tech[3]	Reference post-tech with hours reduction[4]
	(Thousands)		
Total employment	12,526	12,692	13,075
Cumulative displacement to 1995	350	351	357
	(Per cent)		
Cumulative displacement to 1995	2.8	2.8	2.7
Unemployment rate[5]	10.5	9.3	6.6

1 Under a scenario of faster diffusion than empirically observed; import penetration and exports of equipment, however, are as empirically observed.
2 The reference path is the path that allows output, industry outputs, allocation of demand across sectors, and working hours to evolve according to the historical rate of change.
3 The reference, post-tech path is the reference path minus the impact of microelectronic-based technological change on outputs and inputs.
4 The reference, post-tech path with the weekly hours reduced by 5 per cent for each sector.
5 Assuming that displaced workers are re-employed, using the new structure.

SOURCE Based on simulation results of MESIM.

Institutional Support

In this section we describe briefly three Canadian organizations that are involved in the concept of alternative work-time arrangements – one from the private sector and two from the public sector. Work Well is a private body funded by Employment and Immigration Canada. Its primary purpose is to provide information and assistance to individuals desiring changes in their working time. One of its roles is to match potential job sharers; another is to apprise workers of the advantages of taking up telecommuting as a work option.

The federal government itself is also concerned with the issue of alternative work arrangements, through the Innovation component of Employment and Immigration Canada's Canadian Jobs Strategy.[40] Under this program, new ways of responding to labour-market problems may be funded, including innovative work arrangements.

Another public organization facilitating changes in work time is the Quebec Ministry of Employment and Job Security, which maintains a Joint Program for Alternative Work Schedules (PACTT in French). Under this innovative program – the first of its kind in North America – the Quebec government seeks "to create alternative types of work schedules for the purpose of promoting access to the workplace for the unemployed through a voluntary reduction in working time, or by having employees share work schedules."[41] To this end, the ministry provides information and financing to companies and municipalities that agree to implement a reduction in work schedules on a career-long basis (phased retirement, sabbatical leave, and so on), on a yearly basis (extending annual vacation), or on a weekly basis (personal reduction, general reduction in overtime, or job sharing). Assistance is also available to groups of employees who are considering a reduction in their work schedules. All this must take place as a cooperative effort of the unions and businesses concerned, and the net effect of the freed-up hours must be the creation of new positions.

To date, close to 60 organizations have shown interest in PACTT, whose life has recently been extended to April 1989; five groups have signed agreements.[42] In one of those, a company had just introduced a new technology and, as a result, was about to lose 10 employees. By a judicious rearrangement of working time among the existing staff – which involved a reduction in the work week by two hours, the abolition of overtime, and early retirement of some of its workers – the company was able not only to rehire the 10 employees who were about to be laid off but also to hire seven additional staff members, for a net job creation of 17.

Conclusion

A prominent focus of our research has concerned a variety of organizational arrangements. Innovativeness resides not only in new hardware but also in flexible, participative, and responsive organizations. It is clear that both the human and the technological sides of the change equation must be addressed if Canadian organizations are to meet the challenges of a fiercely competitive trading environment.

The approaches discussed in this chapter have the potential for contributing to both improved corporate performance and a better quality of life at work. We stress that there is no single universal panacea; firms must build their own innovations and do so *continuously*. We have found many valuable Canadian examples of flexible working-time arrangements, job redesign, and even sociotechnical systems that show the value of innovative organizational approaches. On balance, however, we reluctantly conclude that most Canadian organizations continue to make decisions, structure organizations, design jobs, and schedule working time according to traditional principles.

8 Technological Change and Industrial Relations

In this chapter, we shall look at the implications of technological change for industrial relations. The industrial relations system in Canada has been built on the cornerstone of collective bargaining. Accordingly, our primary focus here will be on how technological change is affecting the relationship between labour and management in the unionized sector. While workers outside the collective bargaining system are not considered in this chapter's analysis, some of our conclusions suggest new institutional arrangements that would offer more involvement in the implementation process for both union and non-union workers.

The concept of involvement has been raised on a number of occasions in the two preceding chapters. It is fundamental to this one as well. Our research has indicated that participation on the part of all stakeholders is a necessary ingredient for effective technological and organizational innovation. Indeed, there is evidence to suggest that, on a societal level, the economic objectives of both equity and efficiency are served by social contracts where employers, workers, and government are essential parties in decision-making. As we shall see in this chapter, there does not appear to be a great deal of union/management dialogue over technological change in this country, particularly in comparison with some of the other countries that we have looked at. Genuine and constructive collective bargaining regarding the implementation of new technology is an important policy objective, and our analysis suggests the need to consider ways of better achieving this objective.

What Are the Issues?

Industrial relations systems are currently at the crossroads in most developed countries. These systems, based on collective worker representation, have not fared well in the increasingly competitive international economy of the late twentieth century. This is perhaps most evident in the United States, where a declining union movement, more aggressive employers, and public-policy shifts are putting labour "on the ropes."[1] Even in western European countries where the environment has been more favourable, organized labour – and hence collective bargaining – is facing considerable difficulties.[2]

The Canadian story includes elements of both the U.S. and European situations. The attitude to the principle of collective bargaining in this country appears to be closer to that in Europe. In Canada, there does not appear to be the widespread questioning regarding the fundamental usefulness and necessity of unions that we see in the United States. In contrast to the American experience, unionization has not declined in this country. Membership has grown by about one million workers over the past dozen years and accounts for roughly 40 per cent of the nonagricultural paid labour force. Furthermore, the support of public policy for collective bargaining has not shifted perceptively here. There have been recent examples of favourable legislation being enacted, such as the imposition of first-contract arbitration in Ontario. Also, general enforcement of labour relations legislation does not appear to have undermined the principle of collective bargaining, again in contrast to the United States.[3]

Nevertheless, there are challenges to the collective bargaining system here as well. Much of the growth in unionism over the past two decades has taken place in the public sector. Considering private industry alone, levels of unionization, excluding the service sector, have been static or in decline since the 1960s (Table 8-1).

Table 8-1

Union Density Trends and Employment Growth, by Industry, Canada, 1962-84

	Union membership as a proportion of paid workers		Employment growth
	1962	1984	1962-84
		(Per cent)	
Primary industries[1]	45.7	34.1	64.0
Manufacturing	42.4	45.0	31.0
Construction	47.7	38.8	45.5
Transportation, communications, and utilities	56.4	60.0	45.9
Trade	5.3	12.5	83.9
Finance, insurance, and real estate	0.2	9.2	154.4
Services	8.8	38.1	180.0
Public administration	24.9	66.6	118.5

1 Excludes agriculture.

SOURCE Based on Industrial Relations Centre, Queen's University, *The Current Industrial Relations Scene in Canada*, 1985, 1986 and data from Statistics Canada, Labour Force Survey.

Certainly, collective bargaining trends have been affected significantly by structural shifts in the economy. Earlier in this report, we documented the dynamic nature of the Canadian economy throughout the twentieth century. Changing economic patterns have constantly transformed the locus of employment, most recently from manufacturing to the service sector. This structural change has presented a challenge to the industrial relations system. While industries with entrenched collective bargaining are now slow-growth sectors, the economy has been expanding in sectors historically outside collective bargaining or, at least, without any such tradition (Table 8-1).

The economic environment faced by firms in Canada, as in other developed countries, also presents challenges for the collective bargaining system. In response to the recession of the early 1980s, there has been a widespread corporate "shakedown" fueled by the conclusion that the heightened international competition can be survived only through substantial productivity growth. This has led to a greater-than-ever emphasis on cost-cutting and operational flexibility. Historically, this kind of environment has tended not to be a favourable one for unions.[4]

How does technological change fit into these trends? Above all, the new generation of computer innovations is seen as an essential tool for survival and growth in a competitive world. As the results of our Working with Technology Survey show, these technologies are most typically introduced to enhance productivity – often by creating savings in labour costs.[5] The new technologies also simultaneously increase employers' requirements for operational flexibility and allows that increased flexibility to be realized. Indeed, it has often been noted that the distinguishing characteristic of the computer-based technologies is their capacity for responding to constant changes in production. More than just improving mass production, they offer what Piore and Sabel have called "flexible specialization."[6]

These features make the new technologies integral to the plans of much of Canadian industry. As we noted in an earlier chapter, about 85 per cent of the firms that responded to our survey expect to have introduced some computer-based technology by the end of this decade. This technological change brings with it considerable opportunities for improving labour-management relations through information sharing and joint resolution of concerns of mutual interest. At the same time, however, technological change is creating difficult issues for an already-challenged collective-bargaining system. Included among these issues are: first, implications for union coverage; second, potential bargaining-power effects; and, third, negotiations over the implementation of technological change.

The new technologies appear to be threatening union membership by accelerating employment shifts away from traditionally unionized occupations. In making this observation, we have returned to the technological characterization of industries used in earlier chapters. It should be recalled that industries were designated as

Table 8-2

Collective-Bargaining Coverage and Occupational Composition, by Technological Sector,[1] Canada, 1980

	Proportion of "nonexcluded" work force in all industries		Proportion in manufacturing with collective-bargaining coverage
	With collective-bargaining coverage	In blue-collar category	
	(Per cent)		
Technological sector			
High-tech	58.0	66.4	54.3
Mid-tech	66.9	77.2	67.3
Low-tech	62.8	78.5	62.0
All industries	62.3	73.4	61.8

Note Figures are mean industrial averages.
1 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top-ranking one-third were considered to be high-tech; the middle one-third, mid-tech; and the lowest one-third, low-tech.
Source Based on Labour Canada, *Wages and Working Conditions*, 1980.

high-, mid-, or low-technology sectors on the basis of the extent to which they utilize "high-technology" inputs in production. With this classification and with industry-level data on collective-bargaining coverage, we can consider the technology/unionism relationship.

Our analysis indicates that the extent of collective bargaining does vary according to an industry's technology level. The percentage of workers under collective bargaining is lowest in industries characterized as "high-technology" (Table 8-2). Relative coverage levels in high-technology industries are particularly low within the manufacturing sector.

What lies behind the negative relationship between industry technology levels and the extent of collective bargaining coverage? While a number of factors may be contributing, our results highlight the importance of the occupational composition implications of technological advance. While collective bargaining coverage has grown considerably within some white-collar occupations over the past two decades, union membership, particularly in the private sector, remains most concentrated among blue-collar workers.[7] While there is a secular pattern away from blue-collar employment throughout the economy, it seems that this trend is particularly marked in high-technology sectors (Table 8-2).

Corroborating evidence comes from the Working with Technology Survey, where employment in 1985 for skilled and general manual labour – again, the traditional occupational source of union membership – was significantly less among respondents identified as innovators than among non-innovators. Similarly, both managerial and professional and technical employment levels were higher among innovators than non-innovators (Chart 8-1). These occupations, of course, have low rates of unionization and, in many cases, are even excluded from collective bargaining protection.

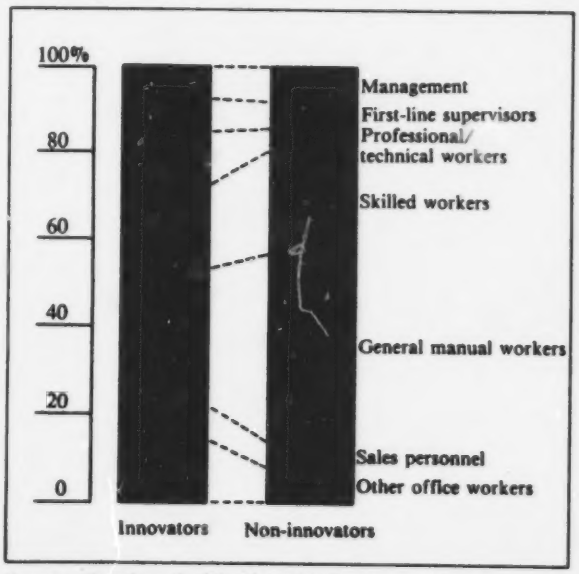
A second area of concern involves the implications of technological change for the relative bargaining power of unions and employers. An underlying principle of collective bargaining is some sense of a balance of power between the parties.[8] There are many different factors determining the distribution of bargaining power, and as these factors change, the balance shifts as well. The fundamental source of power for unions rests with the collectivity of workers and their capacity to disrupt operations by withdrawing services. It has been argued that technological change, at least in some situations, offers employers the potential to control production "off the shop floor." Where the new technologies diminish the indispensability of union labour and particularly where they enable the maintenance of operations during a strike, the balance of power may shift considerably.[9] It should be noted that these implications are by no means well established. Indeed, the opposite contention – that technological change increases the indispensability, and thus the power, of at least some workers – has also been made.[10]

On balance, it is likely that the effects of the new technologies depend very much on how they are implemented. The importance of how innovation is managed has been underlined in preceding chapters. Research suggests that in a collective-bargaining setting, all parties benefit when management and the union work together and negotiate agreements regarding technological change. For example, this is the conclusion of a study on bargaining over new technologies in companies in five European countries.[11] Not only were employee concerns over a range of work issues more effectively handled but, also, the pace and success of technological change improved where real union/management cooperation took place.

The European study drew a distinction between genuine and "lip-service" participatory approaches. In the former, information is shared, and discussions are frank and open. To achieve this is a challenge for both management and unions. Employers must be prepared to involve workers and their representatives in the inno-

Chart 8-1

Occupational Structure of Innovating and Non-Innovating Establishments, Canada, 1985



SOURCE Based on the Working with Technology Survey, Economic Council of Canada, 1985.

vation process. Admittedly, this implies giving up some control over what has traditionally been managerial prerogative. Our survey results suggest that to this point, the majority of Canadian firms have been hesitant to adopt participatory approaches. Less than one-quarter of the innovating establishments indicated that worker groups had been involved in planning for technological change, and even fewer reported the participation of joint labour/management committees.

While, typically, employers have been reluctant to bring unions into the decision-making process, labour, for its part, has sometimes been opposed to the idea of change. This stance has not always served the union movement well. As evidence, the President of the Communications Workers of America cites the example of the horsecollar makers – one of the strongest unions at the turn of the century. Had they not refused to switch their skills when the car was invented – to make fanbelts, for example – the horsecollar makers might have become the autoworkers of today rather than merely a footnote in history![12]

Horsecollar makers notwithstanding, available evidence indicates that, generally, Canadian unions and their members are not opposed in principle to technological change. Rather, the negative attitudes that exist pertain more to the ways in which new technologies are implemented. In 1985, the Canadian Labour Congress carried out a public-opinion poll regarding worker attitudes to technological change.[13] While 64 per cent of the respondents felt that technological change decreased the number of jobs, two-thirds believed that dangerous work was eliminated, and 59 per cent said that more challenging jobs were created. The majority of people interviewed noted the importance of employer responsibility for adjustments to technological change – in the form of retraining, sharing productivity gains, providing advance notice, and consulting with workers.

Similar attitudes were expressed in a survey of union officials that was conducted in the early 1980s.[14] The dominant feeling was the acceptance of technological change "as long as consultation precedes the introduction of change, and management undertakes to make every effort to minimize the adverse effects on workers."[15] Very few unions, however, indicated any serious involvement in consultation or bargaining on technology and its implications.

Delegates to the United Steelworkers' policy convention in 1983 were surveyed regarding technological change and its impacts on their membership.[16] On balance, the respondents did not express opposition but did indicate some concern with respect to the implementation of the new technologies. About half of the delegates felt that technological change had disemployment effects, but most did not see harmful implications regarding skill levels, health and safety, or surveillance. In terms of overall attitudes to technological change, only 4 per cent were hostile, while 32 per cent were receptive or enthusiastic; however, 56 per cent were uneasy. This uneasiness presumably stemmed from the union's inability to influence the introduction of the new technologies and to negotiate satisfactory contract provisions. The majority of delegates reported that their local had not been consulted in advance about technological change. Furthermore, their assessment of relevant language in their agreements was generally unfavourable (Table 8-3). Only safety and health received a good evaluation. Provisions pertaining to all other issues were, in most cases, either nonexistent or judged to be weak.

Evidence on the contents of labour agreements is of particular interest, since collective bargaining is the cornerstone of our industrial relations system. In the Canadian model, conditions of employment are ideally

Table 8-3

Assessment by Steelworker Officials of Technology-Related Clauses in Collective Agreements, 1983

	Proportion of total delegates in each category		
	Strong or moderate language	Weak or no language	Don't know
	(Per cent)		
Notice/disclosure of employer plans	20	74	6
Definition of tech change	19	78	3
Job security/ income security	35	64	1
New classifications	49	51	1
Training/ retraining	35	64	2
Shorter hours/no pay reduction	5	94	1
Severance/ termination pay	17	82	2
Early retirement	31	69	1
Safety and health	71	28	1
Transfer rights/ relocation	45	53	2
Monitoring of employees	11	87	3
Special provisions for VDTs	12	82	6

Source: Gordon Betcherman, "Results of the USWA technology survey, May 1983," unpublished paper, 1985. A summary of this report was published in the proceedings of the *Steelworkers' Canadian Policy Conference* (Toronto, 1985).

negotiated by unions and employers. As we have seen, technological change raises a number of issues. Are these being negotiated through the collective-agreement mechanism? In the next section, we shall look at technology provisions in Canadian contracts. As the preceding paragraphs might suggest, this analysis indicates a low incidence of bargaining language regarding technological change and its effects.

Collective Agreement Analysis

Here, we focus on the incidence of technological change language in Canadian agreements. The provisions of special interest to us are those dealing with advance notice and/or consultation prior to the introduction of a technological change, technology-related retraining clauses, employment or income guarantees related to technological change, labour/management committees on technological change, and technology-related relocation allowances. Because contracting-out represents a shift in the production "recipe" – much like technological change – we also include those provisions in the analysis.

We should note that the research to be reported in this section assumes that a collective agreement, as the historical record of negotiations between labour and management, can be dealt with in a quantitative fashion. It is evident that the language contained in an agreement is not easily classified: clauses are complex, not only in their wording but also in their interpretation. Experienced participants in collective bargaining recognize that formal provisions and real arrangements are not always the same. Nevertheless, written agreements are the "rule book" governing the union/management relationship and, as such, are an important source of information. It is important to recognize that the statistics derived from agreement clauses must be supplemented with other, more qualitative information.

Technological Change Legislation

Before looking at the agreements, it is important to note that four Canadian jurisdictions have passed legislation directed at collective bargaining and technological change. The general intention of this legislation has been to provide for opening negotiations on relevant employment conditions when major technological change has been introduced during the life of a contract. In the federal jurisdiction (*Canada Labour Code*, sections 149-153), legislation passed in 1972 requires an employer proposing to introduce technological change "likely to affect a significant number of employees" to notify the bargaining agent by means of a detailed notice well in advance of the date when the change is to be effected. Originally 90 days, the notice period was increased to 120 days after a 1984 amendment to the *Canada Labour Code*. Upon receipt of the notice, the bargaining agent can apply to the Canada Labour Relations Board for permission to begin bargaining over those provisions of the agreement to be affected by the proposed change. When such an application has been filed, the employer cannot legally introduce the change until the Board has refused the application, a negotiated settlement has been reached, or the parties are in a legal strike/lockout position.

Technological change legislation was also passed during the early 1970s in three provincial jurisdictions – Manitoba, Saskatchewan, and British Columbia. The Manitoba provisions (sections 72-75 of the *Labour Relations Act*) and Saskatchewan provisions (section 43 of the *Trade Union Act*) are generally similar to the federal ones, except that neither province has increased its 90-day notice period. Like the federal law, Manitoba's requires a detailed written notice: when this notice has been given, the bargaining agent may, as in the federal jurisdiction, serve notice to begin negotiations for revision or renewal of the agreement. Under Manitoba law, an agreement will terminate 90 days after such notice is given or on its expiry date, whichever comes first. In addition, disputes relating to notice or the failure to give notice may be submitted to arbitration. Saskatchewan's law differs in that it gives the trade union a set length of time (30 days) to serve notice to bargain after the notice has been received. The employer is not legally free to introduce the technological change in question unless the Board has relieved him of the duty to bargain, or until the parties have either reached agreement or come to a legal strike/lockout position.

An important feature of these three pieces of legislation is the so-called "opting-out" provision. For instance, Section 149(2) of the *Canada Labour Code* states that the technological-change provisions do not apply: a) when the employer has given notice in writing "substantially in accordance" with the notice period required by the Code, b) when the collective agreement contains provisions for the negotiation and resolution of any matters relating "to terms and conditions or security of employment likely to be affected by a technological change," or c) when the agreement states that the provisions of the Code do not apply during the life of the agreement. Manitoba's "opting-out" provisions are similar. The Saskatchewan provision is rather more limited; only if the agreement actually contains provisions for negotiating and settling technology-related disputes is the employer relieved of the necessity to comply with the legislation.

British Columbia is generally considered to offer workers the best protection of any jurisdiction against

the effects of technological change. That province's labour law differs significantly from that of the other three jurisdictions we have been considering. Its most notable feature is that, in effect, it mandates technological change provisions, or at least provisions for dealing with disputes arising over the issue of change. Specifically, the *British Columbia Labour Code* states that every agreement shall contain provisions for resolving – through arbitration or other means – disputes over technological change and that if no provisions are contained in an agreement, the Minister of Labour may prescribe them. When an employer intends to institute a change affecting a significant number of employees, the matter may be referred to an arbitration board, which may order a number of possible remedies for the affected employees. The arbitration board may also recommend the appointment of a special officer or order negotiations to begin for the purpose of revising the provisions relating to terms, conditions, or security of employment; in the latter case, the prohibition against strikes or lockouts during the life of the agreement does not apply. Perhaps most important of all, the B.C. Code does not contain the "opting-out" language that is part of the other jurisdictions' legislation.

Technological Change Provisions

In the ensuing analysis of collective agreements, we focus on two main questions:

- How frequently do certain key technological change clauses occur in Canadian agreements?
- Has the incidence of any or all of these clauses changed appreciably over time?

In answering the latter question, we shall be particularly interested in seeing whether the incidence of these clauses increased markedly in those jurisdictions which have technological change legislation during the period immediately following passage of that legislation.

Throughout most of the chapter, we deal solely with agreements covering 500 or more workers, since these are the only ones regularly coded by Labour Canada's Collective Bargaining Division throughout our study period. But agreements of this size may well not be representative of workplaces in general. Smaller organizations are likely to face some different problems in adjusting to innovation and to use different types of solutions.[17] Accordingly, our analysis of large bargaining units is supplemented by a look at how technological change has been negotiated in smaller units. In this way, we can also consider other issues, including the relative advantages of larger as opposed to smaller bargaining units in attaining these provisions.

How frequently do technological change clauses appear in Canadian agreements? The short answer, which stands up quite well to more detailed analysis, is: "Not very." Even though, as the small agreement analysis will demonstrate, workers in units of 500 or more are far more apt to have technological-change provisions written into their agreements than those in smaller establishments, these provisions still cover only a minority of workers in the large units.

The most common technology-related clause in Canadian agreements is, and always has been, advance notice and/or consultation prior to the introduction of a workplace change. In 1985, 38.0 per cent of all large-unit agreements, covering 42.1 per cent of all "large agreement" workers, contained such a provision (Table 8-4). Even where advance notice provisions exist, the length of notice required is often quite short. Only 25 per cent of large-unit workers were covered by contracts stipulating notice of changes at least three months in advance.[18]

The incidence of the other clauses is even lower. As Table 8-4 shows, the percentage of workers covered by the other technological change provisions we have exam-

Table 8-4

Frequency of Various Technological Change Provisions in Collective Agreements,[1] Canada, 1985

	Proportion of total	
	Agreements containing provision	Workers covered by provision
	(Per cent)	
Provisions:		
Advance notice/consultation	38.0	42.1
Training/retraining	31.1	31.5
Relocation allowance	4.3	9.1
Labour/management committee on tech-change issues	14.6	22.2
Employment security in case of tech change	22.7	25.4
Notice of layoff resulting from tech change	12.7	15.3
Contracting-out prohibitions	31.3	30.1

1 Agreements covering 500 or more workers, exclusive of construction.
Source: Based on data from Labour Canada, Collective Bargaining Division.

ined ranges from 31 per cent in the case of retraining to a low of 9 per cent for relocation allowances. Only 22 per cent of the sample's employees work in establishments where there is a labour/management committee to deal with technological change.[19]

In 1972 and 1973, as we said earlier, the federal government and three of the provinces passed legislation intended to encourage bargaining over technological change. But did technology clauses become more frequent in Canadian agreements as a result? To consider this question, we have examined trends in the incidence of four particularly important technology-related clauses (advance notice/consultation; training/retraining; labour/management committees; and employment security) over time.[20] Our analysis suggests that any gain in these areas has, for the most part, been quite modest (Table 8-5). Moreover, the increase in frequency largely took place after 1978 rather than between 1972 and 1978 – the immediate post-legislation years. During the earlier period, three of the four areas under discussion remained virtually static or experienced an actual decline in frequency.

While this evidence cannot be considered conclusive, it suggests that other factors, such as rising unemployment or an increase in the rate of workplace change, may well have been more responsible for the increase in technological change provisions between 1972 and 1985 than the legislation. Of course, in order to get at the precise impact of the legislation, we have to look specifically at the relevant jurisdictions, which we do later in this section.

One way of comparing the incidence of clauses among jurisdictions or industries is to calculate a "simple average frequency."[21] For each bargaining unit, as we have noted, we consider seven technology-related provisions. The percentage of these provisions present in each contract is then calculated, with the "simple average frequency" computed as the bargaining unit mean for a group of contracts. The national "simple average frequency" was 21.8 per cent in 1985: in other words, the typical "large-unit" agreement did not even have two of the seven provisions of interest.

There are considerable differences in the incidence of technological-change provisions by industry (Table 8-6). These clauses are fairly strongly localized in a comparative handful of industries – usually older sectors with steady or declining employment (Table 8-7). That such industries would have a relatively high incidence of technological change clauses is quite understandable, given the concern of their workers and unions for job protection.

Of the industries we have looked at, by far the highest frequency of provisions is found in pulp and paper, with a simple average frequency of 68.4 per cent. All but one of the 43 pulp and paper contracts in the large agreement pool contain an advance notice clause, while only one agreement lacks a guaranteed employment/earnings clause. Likewise, the industry is far ahead of all others in the areas of labour/management committees and notice of layoff. In training clauses, it ranks second to smelting and refining; in contracting-out prohibitions, second to shipbuilding. Only in the

Table 8-5

Frequency of Technological Change Provisions in Collective Agreements, Canada, Selected Years, 1972-85[1]

	Percentage of agreements covered						Percentage of workers covered					
	1972	1978	1980	1982	1984	1985	1972	1978	1980	1982	1984	1985
	(Per cent)											
Advance notice/consultation	27.4	28.5	33.5	35.5	38.1	38.0	35.5	34.9	40.2	41.6	42.7	42.1
Training/retraining	22.7	21.7	25.5	28.7	31.1	31.1	28.1	27.8	29.9	32.5	31.5	31.5
Labour/management committee on tech change issues	13.9	12.3	14.9	14.7	14.3	14.6	17.3	21.0	25.6	22.3	20.8	22.2
Employment security (tech-change related)	12.1	18.1	19.9	21.2	21.9	22.7	15.2	23.8	24.7	24.1	24.0	25.4

1 Agreements covering 500 or more workers. Construction is excluded 1979-85.
Source Based on data from Labour Canada, Collective Bargaining Division.

Table 8-6

Frequency of Technological Change Clauses in Collective Agreements,[1] Selected Industries,[2] Canada, 1985

	No. of agreements	Proportion of total agreements with each provision							
		Advance notice	Training/ retraining	Relocation allowance	Labour/ management committees	Guaranteed employment/ earnings	Notice of layoff	Contracting out prohibitions	Simple average frequency[3]
		(Per cent)							
Industry:									
Logging	10	40.0	40.0	-	-	20.0	10.0	10.0	17.1
Miscellaneous metal mines	14	85.7	64.3	-	7.1	64.3	14.3	57.1	41.8
Pulp and paper mills	43	97.7	68.8	-	74.4	97.7	76.7	55.8	68.4
Iron and steel mills	12	58.3	58.3	8.3	-	66.7	16.7	50.0	36.9
Smelting and refining	15	73.3	86.7	6.7	33.3	73.3	-	40.0	44.8
Motor vehicle parts and accessories	13	30.8	53.8	-	30.8	-	-	15.4	18.7
Shipbuilding and repair	10	80.0	70.0	-	40.0	-	-	70.0	37.1
Communications equipment	12	33.3	50.0	8.3	-	16.7	-	25.0	19.0
Air transport	13	23.1	15.4	7.7	-	7.7	15.4	15.4	12.1
Railway transport	16	75.0	37.5	62.5	25.0	31.3	-	37.5	38.4
Urban transit systems	10	50.0	30.0	-	-	40.0	30.0	30.0	25.7
Telephone systems	19	68.4	42.1	21.1	15.8	10.5	10.5	36.8	29.3
Electric power	19	31.6	52.6	10.5	31.6	52.6	15.8	36.8	33.1
Grocery stores	27	29.6	29.6	-	-	14.8	7.4	7.4	12.7
Elementary and secondary schools	149	3.4	2.0	-	0.7	4.0	0.7	13.4	3.5
Postsecondary non-university educational institutions	11	9.1	9.1	-	-	-	-	36.3	7.8
Universities and colleges	36	36.1	36.1	-	8.3	16.7	22.2	33.3	21.8
Hospitals	74	37.8	20.3	-	8.1	9.5	14.9	40.5	18.7
Hotels and motels	12	-	8.3	-	-	8.3	-	16.7	4.8
Federal administration (except defence)	37	54.1	-	-	51.4	-	8.1	5.4	17.0
Provincial administration	56	42.9	28.6	1.8	25.0	5.4	25.0	19.6	21.2
Local administration	51	25.5	29.4	-	-	45.1	7.8	39.2	21.0
All above industries	659	36.9	28.4	3.2	15.5	22.2	13.8	28.1	21.1
All other industries	301	40.5	35.9	6.3	13.3	21.9	9.6	35.2	23.3

1 Covering 500 or more workers.
2 Industries with 10 or more agreements.
3 The "simple average frequency" was obtained by taking the mean of the technological-change-clause incidence in each industry.
SOURCE Based on data from Labour Canada, Collective Bargaining Division.

Table 8-7

Industries with Highest and Lowest Simple Average Frequencies of Technological Change Clauses in Collective Agreements,[1] Canada, 1985

Five highest		Five lowest	
Industry:	(Per cent)	Industry:	(Per cent)
Pulp and paper mills	68.4	Primary and secondary schools	3.5
Smelting and refining	44.8	Hotels and motels	4.8
Miscellaneous metal mines	41.8	Postsecondary non-university educational institutions	7.8
Rail transport	38.4	Air transport	12.1
Shipbuilding and repair	37.1	Grocery stores	12.7

1 Ten or more agreements per industry, covering 500 or more workers.
SOURCE Based on data from Labour Canada, Collective Bargaining Division.

area of relocation allowances – generally quite rare in Canadian agreements – is the pulp and paper industry not dominant.[22]

This pattern of long-established protection is not the case in some newer sectors – for example, the telephone industry, where technology provisions have increased significantly over the period under consideration. Here, the major increase occurred between 1978 and 1980 – a pattern that suggests other factors were probably more responsible for the provisions than the influence of any legislation. Likewise, the legislation seems to have had little to do with the incidence of clauses in the pulp and paper industry, since the great bulk were in place before enactment of the laws.

Considering the simple frequency measure by jurisdiction, the three highest ranking provinces are Newfoundland, Quebec, and British Columbia (Table 8-8). New Brunswick, Ontario, Saskatchewan, and Alberta have the lowest frequencies. Why are there these jurisdictional differences? Certainly, they reflect, in part, geographical patterns of industrial structure. For example, many pulp and paper agreements are from British Columbia, which, as we have seen, has a provision frequency far above the national average. In addition, there does appear to be at least a moderately strong correlation between provision frequency and union density,[23] supporting the notion that unions will be better able to negotiate technological change clauses in the presence of a stronger rather than a weaker labour movement.[24]

On balance, there does not appear to be a consistent connection between the existence of technological change legislation in a particular jurisdiction and the frequency of technological change provisions. Among these jurisdictions, while British Columbia ranks second nationally according to the "simple average frequency" measure, Manitoba and the federal jurisdiction are slightly above the national average, and Saskatchewan is near the bottom of the list despite its legislation. If the technological change legislation has had any impact, it would likely be on the incidence of advance-notice provisions, since these are invariably specified in the laws. The national incidence of advance notice/consultation clauses is about 38 per cent (Table 8-8). While these clauses are most frequent in Manitoba and British Columbia, two provinces without legislation – Newfoundland and Nova Scotia – also rank highly. Moreover, Saskatchewan, with legislation very similar to Manitoba's, is well below the national average with 28 per cent.

The picture presented to this point suggests that technological change legislation has had, at most, a minimal influence on the contents of Canadian agreements. To supplement the analysis of large-unit contracts, which are not necessarily indicative of bargaining units as a whole, we also looked at a representative sample of "smaller-unit" agreements, covering fewer than 500 workers.[25]

Consideration of these agreements is significant, since Canada's bargaining structure is quite decentralized, with many covered workers in small units. In addition to examining the applicability of our "large-unit" findings, we were interested in two other questions: first, whether large units are at a comparative advantage in obtaining technological change protection; and, second, the extent to which certain clauses – such as the definition of technological change, VDT, surveillance, and deskilling – not coded by Labour Canada are found in Canadian agreements.

On these questions, our findings were as follows:

- In general, large agreements are nearly twice as apt to contain technological-change provisions as small ones; the "simple average frequency" figure for the small-unit pool was 13.2 per cent, compared with 21.8 per cent for the large units.

- Larger agreements contained a higher frequency of each of the seven individual clauses under study here than did smaller ones.

Table 8-8

Frequency of Technological Change Clauses in Collective Agreements,[1] by Jurisdiction, Canada, 1985

	No. of agreements	Proportion of total agreements with each provision							
		Advance notice	Training/ retraining	Relocation allowance	Labour/ management committees	Guaranteed employment/ earnings	Notice of layoff	Contracting-out prohibitions	Simple average frequency[2]
		(Per cent)							
Newfoundland	17	52.9	52.9	-	5.9	29.4	23.5	52.9	31.1
Prince Edward Island	4	25.0	25.0	-	50.0	-	-	75.0	25.0
Nova Scotia	25	52.0	36.0	-	20.0	16.0	12.0	24.0	22.9
New Brunswick	26	23.1	19.2	3.8	19.2	15.4	3.8	50.0	19.2
Quebec	183	41.5	41.5	1.6	18.0	36.6	14.2	53.6	29.6
Ontario	318	24.5	22.3	0.3	9.1	15.1	9.1	22.0	14.6
Manitoba	43	65.1	51.2	2.3	-	20.9	11.6	25.6	25.2
Saskatchewan	25	28.0	44.0	4.0	12.0	16.0	12.0	16.0	18.9
Alberta	71	19.7	21.1	-	1.4	12.7	9.9	9.9	10.7
British Columbia	113	53.9	41.6	6.2	22.1	30.1	23.9	33.6	30.2
More than one jurisdiction	4	75.0	25.0	-	25.0	-	-	25.0	21.4
Federal, PSSRA[3]	131	52.7	21.4	19.8	28.2	21.4	11.5	23.7	25.5
Total	960	38.0	30.7	4.2	14.8	22.1	12.5	30.3	21.8

1 Covering 500 or more workers, exclusive of construction.
2 The "simple average frequency" was obtained by taking the mean of the technological-change-clause incidence in each industry.
3 Public Service Staff Relations Act.
SOURCE Based on data from Labour Canada, Collective Bargaining Division.

- On the whole, provisions most common in the large agreements (advance notice, training, and contracting-out) were likewise most prevalent in small-unit contracts.

- Related "general" clauses, such as general notice of layoff or general training clauses, were also more frequent in large than in small agreements. Bargaining unit size would thus appear to be as important in negotiating general provisions as in negotiations specific to technological change protection.

- "New technology" provisions are extremely rare: only 5 per cent of the small agreement sample contained definition clauses;[26] 2 per cent, VDT clauses; and 1 per cent, provisions dealing with deskilling. There were no surveillance camera or electronic monitoring provisions at all in the sample.

Why are technological change clauses not more frequent in Canadian agreements, large or small? The available evidence suggests both that unions do not always raise technology issues and that management resistance may be significant. The Council's own survey found that negotiations on technological change had been carried out in only 46 per cent of unionized establishments. When unions did raise these issues, they were successful about half the time in changing contract language.

As for the matter of management resistance to negotiating technology issues, some recent evidence from the report of the Ontario Task Force on New Technology and Employment indicates that worker involvement in the implementation of innovation is by no means a universally accepted principle.[27] Most industries covered by the Task Force had low incidences of worker-participation mechanisms (Table 8-9). Moreover,

Table 8-9

Proportion of Firms with Formal Worker Participation in Various Aspects of Business Operations, Ontario, 1984-85

	Setting production or sales targets					
	At company level	At plant level	At department level	At working-group level	Improving productivity/ quality	Adoption of new technology
				(Per cent[1])		
Manufacturing:						
Iron and steel	–	–	–	65	100	65
Metal stamping, pressing, and coating	5	20	50	60	65	20
Hardware, tool, and cutlery	30	30	50	70	90	50
Miscellaneous metal fabricating	5	25	20	–	40	25
Machinery and equipment	–	–	–	30	35	30
Office and store machinery	55	50	65	50	80	65
Communications equipment	15	15	20	25	55	5
Aircraft and aircraft parts	15	10	20	20	50	40
Plastics fabricating	25	30	40	30	70	35
Services:						
Chartered banks	15	20	70	50	35	25
Trust companies	60	60	40	50	70	40
Life insurance	50	40	70	40	75	35
General insurance	25	20	40	40	45	10
Insurance brokers	65	80	80	80	80	55
Federal government	25	20	20	40	55	85
Provincial government	10	–	–	–	35	35
Local government	–	20	–	–	50	30
Telephone systems	50	40	40	60	60	55
Telegraph and cable systems	–	–	–	50	75	–
Food stores	–	–	–	–	–	–
General merchandise stores	..	..	..	..	..	..
Computer services	25	35	50	40	60	60
Management and business consultants	10	20	70	35	70	50

1 Figures rounded to nearest 5 per cent.

SOURCE Report of the Ontario Task Force on Employment and New Technology, *Final Report*, Appendices 4 and 12 (Toronto: Government of Ontario, 1985).

employers generally felt only limited roles were appropriate for labour in the implementation of technological change (Table 8-10).

On balance, then, our collective agreement analysis – including both large and small units – suggests that technological change provisions are relatively uncommon in Canadian agreements. Furthermore, legislation, where it does exist, appears to have had, at most, a minimal influence on bargaining over technology, with the single and partial exception of British Columbia. An additional question concerns the interpretation of contract language on technological change by labour boards and arbitration panels, which we shall now consider.

Enforcement of Technological-Change Provisions

Federal and Provincial Experience: An Overview

The Canada Labour Relations Board (CLRB) has accepted only one case on which to bargain over technological change of all the applications ever brought before it. In 1981, for the first time, the Board gave written reasons for a rejection in the *Ottawa-Carleton Regional Transit Commission* case. To that point, there had been 11 other applications made since 1973, when the technological change provisions first came into force. These cases had been dismissed for a number of reasons: because the change in question was not effected by the employer; the application was untimely; the case was withdrawn; or the Board found the case not to constitute a technological change.[28] Since OC Transpo, the basic story has been much the same. The Board accepted only one of the 12 applications submitted to it between 1 April 1982 and 31 March 1986. The exception was the 1984 *Prince Rupert Grain Terminal Ltd.* case, which we shall presently discuss.

Except in British Columbia, provincial experience has been little different. In Manitoba, according to the Registrar of the province's Labour Relations Board, not only has the Board never granted leave to open bargaining over tech change; it has never even had such an application brought to its attention. The Saskatchewan Labour Relations Board, as of 1985, had had 17 technological change cases brought before it. Five were withdrawn, and one was ruled not to be a technological change under the *Trade Union Act*. The remaining applications were dismissed for a variety of reasons, ranging from lack of timeliness to failure to meet the "significant number" criterion.[29] There has been some Board consideration of technological change cases in British Columbia. Of nine applications brought forward, four were resolved in the unions' favour.[30] While we do not have quantitative data on relevant arbitration cases, it also appears that arbitral enforcement of technological change language has been stronger in British Columbia than elsewhere.

Issues Involved in Interpretation

What, precisely, have been the problems regarding enforcement in technological change cases? First, there is the matter of restrictive definitions of "technological change." Another problem has been the "opting-out" clauses included in the federal, Manitoba, and Saskatchewan laws. The requirement (found in all provincial legislation) that a "significant number" of employees be involved has posed difficulties, as has the requirement that the employment effect be significant. As well, a number of arbitrators have required that technological change be the primary cause of any given layoff or other employment dislocation; this has posed problems in that it is often difficult to separate technological change from other factors. With respect to skills, unions seem to have had little success in gaining compensation for workers either for the "deskilling" effects of some technological changes or for the greater degree of skill required to perform their jobs following other kinds of changes.

The first step in enforcement involves recognition that a technological change has, in fact, taken place. How the term is defined, in agreements as well as in labour legislation, is clearly pivotal.[31] Under the *Canada Labour Code*, a technological change is only deemed to have occurred when the employer has introduced new equipment or materials *and* when there is a change in work methods directly related to the introduction of that new equipment or material. This definition, then, excludes all workplace changes not involving new equipment or materials.

The most restrictive arbitral and labour board decisions have required that technological change involve the introduction of technology completely different from anything previously found in the workplace. For instance, in the 1971 *Prince George Pulp and Paper Ltd.* case, the company had discontinued its barking and chipping operation. The arbitration board ruled that there was "no change of any kind in technology although certain machines may have been speeded up, given more power, or increased in size."[32]

A recent and more subtle illustration of definitional difficulties is provided in the 1985 "phantom codes" *Canada Post Corporation* case.[33] In this instance, the post office had developed "phantom" or dummy codes to allow machine sorting of mail, including mail sent

Table 8-10

Management's Perception of the Appropriate Role of Workers in Making Decisions Regarding Technological Change in Manufacturing and Services, Ontario, 1985

	Proportion of firms identifying these roles as appropriate for workers							
	No involvement	Information only	Advance notice	Explanation referring to job security	Discussion (limited dialogue)	Prior consultation	Explanation/ set-up of training	Full involvement
	(Per cent[1])							
Manufacturing:								
Iron and steel	35	65	-	-	-	-	35	35
Metal stamping, pressing, and coating	30	10	-	10	5	30	5	20
Hardware, tool, and cutlery	5	40	-	5	20	25	-	20
Miscellaneous metal fabricating	30	15	-	15	-	-	-	35
Machinery and equipment	25	-	-	-	-	65	15	15
Office and store machinery	-	25	25	-	-	40	-	30
Communications equipment	55	25	-	15	5	20	5	5
Aircraft and aircraft parts	10	-	-	10	10	45	25	10
Plastics fabricating	5	40	30	15	35	15	15	25
Services:								
Chartered banks	25	15	-	25	-	15	-	60
Trust companies	15	-	-	30	-	10	-	45
Life insurance	-	-	-	-	40	20	20	60
General insurance	-	15	-	15	15	-	-	60
Insurance brokers	30	60	-	30	-	30	-	15
Federal government	-	20	15	-	15	40	-	25
Provincial government	15	20	-	20	25	55	25	-
Local government	10	25	10	10	10	20	-	30
Telephone systems	40	20	-	20	20	60	20	-
Telegraph and cable systems	50	50	-	-	-	50	-	-
Food stores	..	..	..	..	..	..	..	..
General merchandise stores	..	..	..	..	..	..	..	..
Computer services	-	-	25	-	25	25	50	25
Management and business consultants	-	40	-	-	-	-	50	10

1 Figures rounded to nearest 5 per cent.

SOURCE Report of the Ontario Task Force on Employment and New Technology, *Final Report*, Appendices 4 and 12 (Toronto: Government of Ontario, 1985).

out without the proper postal code. Phantom coding eliminated one stage of hand sorting. The union argued that this was a technological change and that management had violated the collective agreement by not adhering to its 120-days'-notice stipulation. Under the agreement, technical change was defined as:

> . . .the introduction by the Employer in the internal processing of mail, of equipment different in nature, type or quantity from that previously utilized. . .a change, related to the introduction of this equipment, in the manner in which the Employer carries on the internal processing of mail and any change in work methods and postal services operations affecting one or more employees.

In a previous case involving the post office, the arbitrator had ruled that technological change must involve a change in equipment as well as in work methods and that *all* the conditions outlined in the definition must be met.[34] In the "phantom code" case, the arbitrator admitted that the wording of the clause in question was uncertain; however, in accordance with a precedence provision in the agreement, he accepted the earlier interpretation of technological change. In his view, the introduction of phantom codes did not involve any introduction of new or modified equipment; without that, technological change had not taken place.

Among other things, a restrictive notion of technological change seems to take insufficient account of the potential impact of new computer technology, particularly software. Of relevance here is a case involving the University of Toronto Library.[35] Even though the union had extremely strong technological change provisions by Canadian standards, the arbitrator did not agree that changes in software, which were followed by the layoff of six workers, amounted to a technological change within the meaning of the agreement. He arrived at his decision even while admitting that various definitions of technological change were possible, since the agreement contained no definition at all.[36]

An indication of what is required to meet the standard of technological change, at least for the CLRB, is provided in the 1984 Prince Rupert Grain case mentioned earlier.[37] Here, the changes were so radical that in the words of Board vice-chairman Brian Keller, it was like "going from the horse and buggy age to the jet age." In the old terminal, a blackboard had been used to mark the contents of each bin. At the new terminal, on the other hand, practically all aspects of the operation were computerized in what Keller described as "state-of-the-art" fashion. The applicant, the Grain Workers' Union, claimed that the move to the new terminal constituted a technological change and that the employer was in violation of the *Canada Labour Code* by not giving at least 120 days' notice. The Board had little difficulty in deciding that the move, whose employment effects were profound – a reduction of nearly three-quarters of the previous work force – constituted a technological change, though, curiously enough, even this favourable ruling did not result in any tangible gain for the union, in terms of a requirement that the employer give further notice.[38]

But few technological changes are as clear-cut as those at Prince Rupert Grain. While technological advance may be popularly conceived of as a change from horses and buggies to jets, most technological change is incremental, involves a minority of the work force at any one time, and is introduced concurrently with other organizational and production changes. While there have been exceptions, these realities of technological change usually have not been recognized in the enforcement of contract language or legislative provisions. Arbitrators and board members have generally remained wedded to restrictive interpretations of what constitutes technological change.

"Opting-out" clauses represent another enforcement problem. We noted earlier that all technological change legislation except that of British Columbia contains language stating that the legislative provisions do not apply under certain circumstances. In the *Canada Labour Code*, for example, this is the case if the agreement contains provisions "intended to assist employees to adjust to the effects of any technological change." CLRB chairman Marc Lapointe has suggested that these "opting-out" clauses are one reason why so few technological-change applications have been brought under that legislation.[39] While the intention might have been to encourage the parties to negotiate, our analysis suggests that opting-out features do not stimulate real bargaining over technological change.

All jurisdictions with technology legislation require the change in question to affect a "significant number" of employees before the legislation can be triggered. Of the four, only Saskatchewan has attempted to set out what it means by a "significant number": where the firm has over 30 employees, 20 per cent must be affected for the change to be considered significant.[40] Quite severe employment effects can result, then, without meeting the significant-number threshold. This also appears to be the situation in the other jurisdictions, with the exception of British Columbia. A good example is the 1985 *Manitoba Pool Elevators* case,[41] where the CLRB agreed that a switch to computerized record-keeping constituted technological change but was unwilling to accept the layoff of more than half of the Pool's clerical group as "significant." In the Board's view, the layoffs should have been measured against the

total number of employees covered by the relevant agreement – that is, the total Pool work force. According to this criterion, the layoffs affected about 4 per cent of the work force and were judged not to be significant.

Some arbitrators have also ruled that not only must the technological change be significant, but the employment effect must also be significant in order to constitute technological change. An example is the 1983 *University of Toronto Library* case discussed earlier. Here, although admitting that a significant *change* had taken place, the arbitrator was not willing to admit a significant *effect*, given that other changes (such as work rescheduling) had been occurring at about the same time.[42]

Related to "significant effect" is the problem of separating technological change from other factors. Employers may argue that the employment effects in question are not the result of technological change but rather "a change undertaken for economic reasons," "a change designed to increase competitiveness," or a "response" to "recessionary" or "inflationary" pressures. We have noted, in earlier chapters, the fact that technological change rarely occurs in isolation; it is usually accompanied by other changes. Sorting out the effects due to various factors can be an extremely difficult problem for a labour board or arbitration panel.

In some instances, arbitrators have been able to disentangle technological change effects.[43] More often, however, this has not been the case. In the 1975 *Reichold Chemical* case, an employee was laid off because of a variety of changes, including the introduction of a secretarial pool, changing job functions, the upgrading of a part-time worker to full-time, and the replacement of a computer terminal with a new machine. Only the last of these was considered technological change, and the arbitration board held that technological change must be the primary cause of job loss for the contract provisions to apply.[44]

Technological change can have employment effects other than straight dislocation or wage reduction. In some cases, the introduction of new machines may demand that employees acquire more skills, work at a more rapid pace, or perform more difficult tasks. This can lead to difficulties concerning job classification and compensation. Some of these issues were raised in the 1986 *Manitoba Museum of Man and Nature* case.[45] The grievor was working as an executive secretary when management introduced IBM display writer equipment into the workplace. Because of the efficiency and capabilities of the display writer, the employee in question began doing work that would not have been possible before, and accordingly maintained that the nature of her job had changed substantially and her position should be reclassified. Museum management admitted that the productivity-enhancing equipment had expanded her duties somewhat but the employer's argument – accepted by the Board – was that the work nonetheless remained basically secretarial and that the nature of this work was not consistent with the responsibilities of positions classified at a higher level.

As we note elsewhere in this document, technological change can have "deskilling," as well as skill-enhancing, effects. Of relevance here is the 1985 *Canadian Newspaper Co.* case dealing with bargaining unit exclusion. In this instance, the union argued that the introduction of a new computer had completely changed the duties of a Chief Operator of Accounting Machines, who had been in an excluded position under the collective agreement for about 12 years. The union's point was that the technological change had eliminated the supervisory work previously performed and had also resulted in the employee's performing considerable bargaining unit work. But the Board rejected the union's "community of interest" argument for inclusion in the unit and held that once the parties had agreed to define the boundaries of the bargaining unit and had incorporated them into their collective agreement, there were "good industrial relations reasons" to maintain the status quo.[46]

The British Columbia Alternative

On balance, the legislative arrangements in British Columbia are more effective than in any other Canadian jurisdiction for stimulating negotiations over technological change and its impacts. One reason is the different definition of technological change contained in the provincial labour code.[47] Also, as previously noted, the B.C. law does not contain an opting-out provision.

Perhaps as a result of these differences, B.C. Board and arbitration cases have diverged from the national mainstream on a number of important issues. Frequently, though not invariably, arbitrators in that province have adopted a far less restrictive definition of technological change than have their counterparts elsewhere in the country.[48] In some cases, the Board and arbitrators have allowed indirect, as well as direct, employment effects to be considered within the ambit of technological change.[49] And they have been much more flexible in their interpretation of the "significant number" concept, at times allowing the layoff of a single worker to be regarded as significant in the sense of the code.[50] What is more, in at least one instance – the Tahsis case (1979) – a work stoppage over a technological change issue was ruled in the union's favour.[51]

International Experiences

How are industrial relations issues associated with technological change handled in other countries? While there are limitations on the extent to which foreign arrangements may be applied to ours, experiences elsewhere – both legislatively and through collective bargaining – may nonetheless be instructive. Accordingly, we shall briefly examine ways in which the industrial relations of technological change are addressed in six countries: the United States, the United Kingdom, Australia, Japan, West Germany, and Sweden. Some of these have comparatively decentralized industrial relations systems similar to ours, while others – most notably Sweden and West Germany – have centralized systems featuring a heavy emphasis on legislation.

In all of these countries, the issues for unions and their members are much the same as those in Canada. As one might expect, the greatest concern arising from technological change everywhere is loss of employment or income. This is followed by concerns about deskilling, health and safety, worker involvement in the implementation process, and the sharing of any resulting productivity gains.[52] These issues – elsewhere, as in Canada – are typically translated into demands for employment and income guarantees; advance notice of technological change; training and retraining programs; joint labour/management committees to monitor the implementation of change; reclassification; and increased wages or reduced hours.

It is important to note that while most workers are very much concerned about the possible negative effects of technological change, few seem to be opposed to new technology as such. We have already reviewed Canadian research leading to this conclusion. Similar findings have been made elsewhere. For instance, a Japanese study showed that 78 per cent of the workers in jobs changed by new technology had a positive attitude to their new jobs and that users of microelectronic equipment tended to show a "deep interest" in their work.[53] And a European Community study showed that workers given advance information about technological change plans did not, by and large, use the information to retard implementation; indeed, their input helped to speed innovation as often as it slowed it down.[54]

Common concerns and attitudes notwithstanding, there is a considerable range in policy approaches to industrial relations and technological change among the countries we consider below. Much of this diversity, of course, reflects the quite different social, political, and economic features characterizing the individual societies themselves.

United States — In some respects, the United States and Canada are similar in terms of how industrial relations issues associated with technological change are handled. In the United States, as in this country, innovation is seen fundamentally as a managerial prerogative, with any explicit consideration of worker concerns arising exclusively through collective bargaining. The two countries differ, however, in the extent to which technological change issues are actually bargained. In the United States, fewer than 20 per cent of agreements covering 1,000 or more workers had *any* technological change clauses in 1983.[55] Most common were advance notice provisions, which were found in 10 per cent of the agreements. As we have seen, the incidence figures in Canada are substantially higher (Table 8-4). Moreover, to an even greater degree than in Canada, U.S. provisions emphasize defensive protection rather than an active role for workers in the introduction of new technology. None of the 1983 large-unit contracts included provisions giving workers the right to be consulted or to negotiate over the implementation of technological change.

The low profile of collective bargaining over technological change in the United States appears to be at least partly the result of a relatively weak union movement and of public policies that differ from those in Canada. In this country, all issues are legitimate subjects for bargaining; indeed, as we have seen, four jurisdictions have enacted legislation intended to support union/management negotiations over technological change. In contrast, in the United States there is no legislative encouragement for such bargaining. In fact, U.S. labour policy, which draws a distinction between issues which are compulsory bargaining subjects and those which are not, has not always considered technological change a mandatory issue. During the 1980s, the *National Labor Relations Act* has been interpreted such that "management decisions regarding new technology are largely insulated from collective bargaining."[56]

On balance, U.S. public policy does not encourage worker involvement in the technological change process. To be sure, there are some interesting union/management approaches to technological change in the United States which have been "privately" negotiated at the company or industry level. One example is provided by the automobile industry, and particularly the GM-UAW Job Opportunity Bank-Security Program negotiated in 1984.[57] Such innovative partnerships, however, are the exception rather than the rule in the United States.

United Kingdom — In the United Kingdom, as well, technological change is viewed essentially as a management prerogative, with worker concerns handled almost entirely through collective bargaining. There is no British legislation dealing with the issue, although the *Employment Protection Act* does offer some protection in the event of layoffs by requiring employers to con-

sult authorized bargaining representatives concerning potentially redundant workers.

Since 1979, British trade union strategy has been to recommend the use of jointly negotiated "new technology agreements" as a means of working out the impacts of new technology.[58] Among the more important issues addressed in such agreements are advance notification and consultation, the provision of information, employment maintenance, worker control, equitable distribution of technology's benefits, and health and safety. There is some evidence of employer unwillingness to enter into these technology contracts. The number of new agreements has fallen off in this decade, and it appears that they apply to only a very small percentage of all British bargaining units, although they are significant in certain sectors, such as insurance and local government.

Where technological change language exists, either in these agreements or in general union contracts, it tends to be defensive, frequently covering, for example, employment security and the protection of job gradings. There is little provision for real participative decision-making. Technology agreements rarely provide for union involvement from the outset, though stipulations regarding notice and consultation are somewhat more frequent.[59]

Collective bargaining over technological change in the United Kingdom, then, has resulted in very little active union involvement in the innovation process. The dominant contract language is defensive in nature, and evidence suggests that employee influence over technological change has been minimal compared with influence in other areas.[60] At the same time, it should be noted that, as in the United States, there are a number of British firms – in the banking industry, for instance – that have managed to work out highly innovative arrangements with their workers.[61]

Australia — In many respects, the Australian situation has resembled that of the countries we have already considered. Historically, technological change has been regarded as coming under management jurisdiction, with little scope for labour involvement in the innovation process. Advance notice and consultation with unions over technological change, for example, have traditionally been infrequent.[62]

In the 1980s, both government and labour in Australia have become more concerned with the employment impacts of the new technologies. Since 1983, the government has actively sought to promote technological change as a cornerstone of its general economic strategy. Among other things, it has developed a national technology strategy and established a Technology Transfer Council to promote technological innovation and diffusion in Australian industry.[63] At the same time, the active cooperation of labour has been sought through the promotion of tripartite mechanisms that directly involve unions in negotiations over the effects of technological change. Australian unions and employers now appear to be negotiating successfully over technological change in some industries. Meanwhile, some arbitration awards have begun to recognize the unions' right to be consulted about the consequences of technological change decisions that affect employment, though arbitrators have almost always stopped well short of allowing labour a role in the actual implementation process.[64]

Australian workers still play quite a limited role in the innovation process compared with their counterparts in some western European countries, but their involvement has increased during this decade. In some cases, unions have made significant policy contributions. For example, the major metal and engineering unions have offered detailed submissions to the federal government, including suggestions as to how the industry can upgrade its technological capacity for both domestic and export markets.[65]

Japan — In comparison to the countries discussed thus far, the Japanese industrial relations system has traditionally operated on a consensual rather than an adversarial approach. This system, at least for the core firms, is based on the "three pillars" now familiar to Western observers: lifetime employment, seniority-based compensation, and enterprise unionism. In response to the security offered by the three pillars, Japanese workers and their representatives have tended to be very flexible in terms of work rules and their deployment within the organization. This flexibility has traditionally been extended to the implementation of new technologies. Where lifetime employment policies have existed, Japanese workers have supported innovation, knowing that any displacement will be handled by retraining and relocation.[66] This acceptance of technological change is confirmed by a number of empirical studies. For instance, a study carried out by the Institute of Science for Labour in 1983 found that over 90 per cent of the respondents felt they could adjust smoothly to new jobs or organizational arrangements.[67] This mirrors the findings of a 1981 survey showing 79 per cent of Japanese workers in favour of introducing new microelectronic machinery, as opposed to just 34 per cent of comparable West German workers.[68]

Largely because of organizational practices, labour in Japan has not traditionally sought explicit negotiated agreements to deal with technological change and its impacts.[69] In recent years, however, a number of con-

cerns – including health and safety; job security, particularly for women and older workers; and employment levels – have become more visible.[70] Perhaps because of pressures such as these, as well as threats to the lifetime employment guarantee, there has been some suggestion of a stronger "collective bargaining" orientation on the part of Japanese unions. Formal collective agreements covering such issues as job security, retraining, and health and safety appear to be becoming more frequent.[71] An example of what might be a "new legalism" in Japanese labour's approach to technological issues is the set of guidelines issued by the Japan Council of Metalworkers' Unions. These guidelines call for prior consultation; job preservation and creation measures, including reduced overtime and shorter hours; expanded training and retraining programs; health and safety standards for robots and VDTs; and special measures to assist those groups most affected by the new technology – including women, the elderly, and the disabled.

West Germany — Industrial relations in West Germany is characterized by a "dual jurisdiction" system: industrywide collective bargaining, and works councils at the level of the firm. It appears that there have been relatively few technological clauses inserted into industrywide agreements, with the exception of certain specific issues, such as environmental stress caused by new technology. In addition to standard defensive job-protection measures, German unions have sought to achieve a reduction in working hours without corresponding wage reductions as a job-preservation measure. Their success has thus far been rather limited, although they achieved some reduction in work hours as a result of a recent bitter strike in the metalworking industries.

Since unions have bargaining rights at the industry level, their negotiating strategy is complicated, at least with respect to particular developments in individual firms. In principle, the works councils, comprised of labour representatives within establishments, provide a mechanism for joint involvement in many areas, including some directly related to the effects of technological change. For example, works councils have the right to codetermine legally requested plans for dismissals resulting from technologically induced job redundancies. As well, job-evaluation systems have traditionally been determined jointly by works councils and management representatives.[72] The councils' effectiveness in dealing with many innovation issues, however, has been limited by legal restrictions on their involvement in technological change. While labour court rulings have supported codetermination in certain situations,[73] the introduction of new technologies is more often viewed as a management prerogative, outside the jurisdiction of the works councils.[74] Perhaps in response to the limitations of the codetermination system, there are some recent examples of unions departing from established institutional arrangements and negotiating comprehensive technology agreements with large German firms.

Sweden — The industrial relations system in Sweden differs substantially from the North American model. Important features of the Swedish approach include an extraordinarily high level of union membership (over 80 per cent of the work force), close partnership between the trade union movement and the powerful Social Democratic Party, a centralized bargaining structure, and an "active" labour market policy. The latter involves a priority on full employment; a solidaristic wage strategy based on equal pay for equal work, regardless of the employer's ability to pay; and very substantial retraining and relocation programs designed to facilitate employment adjustment. A consequence of the solidaristic wage strategy has been a consistent narrowing of earnings differentials over the past quarter century.[75]

Swedish labour market arrangements, at least in part, encourage the support of workers for technological change. The full-employment policy reduces the risk of technology-driven joblessness; the solidaristic wage strategy encourages firm competitiveness, while moderating downward pressure on unit labour costs; and the retraining and relocation programs minimize individual adjustment costs.

The Swedish approach also provides an interesting model of how public policy can address union/management relations, specifically with respect to technological and organizational change. The 1976 *Act on the Joint Regulation of Working Life* sets out a prescription for the codetermination of many issues related to innovation. This Act stipulates that the employer must initiate negotiations on a wide range of issues before decisions on new technologies can be made. The employer is required to postpone final decision-making until negotiations have ended. Furthermore, the union has considerable information rights, with the presumption that workers "should not be regarded as outsiders, but should have the same opportunities of insight and overview as the owners."[76] Additional laws concerned with safety, union representation on boards of directors, and work environment, for example, have further encouraged codetermination.

Swedish unions are characterized by a more active, informed, and progressive attitude toward technological change than their North American counterparts. They tend to support new technologies, seeing them as a tool for building democratic workplaces. In some industries, Swedish unions conduct their own research and development and, in printing, for example, have

been responsible for the introduction of new technologies.[77] There is also an unusually high degree of cooperation between the labour movement and employers. In 1982, the national employers' federation and the blue-collar and white-collar union centrals signed an "Agreement of Efficiency and Participation." Features of this pact relating to technological change included joint recognition of:

- the competitive importance of technical modernization;
- sound job content and opportunities for the enhancement of skills and responsibility in the event of technological change;
- the participation of unions in innovation; and
- employer-sponsored retraining, and unchanged pay and employment conditions, following technological displacement.[78]

Clearly, worker involvement in the process of technological change is taken seriously in Sweden. Moreover, as we have seen in the previous chapter, some of the most innovative organizational designs have come from that country. Nevertheless, there are some indications that the Swedish model, at least in its present form, is being subjected to serious challenges. Since 1979, the employers' association has been seeking to reform the centralized wage bargaining and the solidaristic wage policy. As well, questions have been raised about how effectively the active labour-market approach can continue to keep real unemployment down, and wage levels and social spending up, in the increasingly competitive international economy. Finally, there appears to be growing resentment on the part of highly skilled workers over the solidaristic wage policy and its attendant earnings compression.[79] Whether the Swedish approach to technological change can be maintained in the face of such institutional strains is a difficult question.

Conclusion

In this chapter, we have reviewed various industrial relations issues associated with technological change. In particular, we have focused on some implications of the new technologies for the collective bargaining system in Canada. Collective bargaining in this country, as elsewhere, is facing a number of challenges. Some of these – union coverage and the balance of power, for example – may be exacerbated by technological change. The actual impacts will be heavily influenced by the ways in which the new technologies are implemented. Indeed, the value of worker involvement in the innovation process has been a theme running through this report.

Available evidence suggests that the major concern of workers in Canada and elsewhere is not with technological change itself but rather, with their lack of participation in its management. Our review of collective bargaining over technological change in Canada confirms that there is relatively little real negotiation over the introduction of the new technologies and their impacts. Technology-related provisions are found in only a minority of labour agreements, and where contract language does exist, it tends to be enforced quite weakly. Moreover, in those jurisdictions where technological change is contemplated in labour-relations legislation, the laws and their interpretation do not seem to have made a significant difference.

The voluntary negotiation of employment conditions through the mechanism of collective bargaining has been a cornerstone of public policy in industrial relations in this country. If technological change issues are to be addressed through traditional collective bargaining, the *British Columbia Labour Code* seems to offer the framework most likely to encourage serious and productive bargaining. In that jurisdiction, the term itself is defined in a less restrictive fashion, more in accord with contemporary workplace realities. There are no "opting-out" provisions. And interpretation of contracts has more readily disentangled technological change from general economic effects and recognized the subtleties of the "significant number" concept here than elsewhere in Canada.

Effective industrial relations in this area must include, but also go beyond, formal collective bargaining. In all the countries that we have looked at that rely on this approach – the United States, the United Kingdom, and Australia, as well as Canada – there are low levels of real negotiation over technological change. Obstacles come, in part, from the presumption that the introduction of new technologies is a managerial prerogative and from the inability of unions to develop technological change as a bargaining priority.

An additional constraint with the formal collective-bargaining approach is its limited coverage. In Canada, at least half of the work force appears to be outside its collective-bargaining system.[80] Yet, as the Council's survey shows, technological change affects unorganized workers to just about the same extent as the organized. Many of those not represented are excluded from unionization rights by provincial labour legislation.[81] This limited coverage and the pervasiveness of technological change would seem to suggest that in addition to collective bargaining, policy approaches covering all workers might be needed.

Our international review has emphasized for us the importance of institutions that encourage labour/management discussion and a problem-solving approach to industrial innovation. Where this takes place, technological and organizational change seem to be widely viewed in a positive light as a tool for enhancing both competitiveness and the workplace environment. Clearly, a cooperative approach is a complex one to develop and, as recent trends in Japan and Sweden suggest, to sustain as well. Nevertheless, with very different institutional arrangements, those two countries appear to have been more successful than others in creating an industrial-relations environment that effectively deals with technological change and its consequences. Two features common to the Japanese and Swedish experiences are some notion of employment security in the labour market and "voice" in the workplace. These will be very important ingredients in fashioning a consensual model for Canadian organizations.

9 Women and the New Technologies

In the 1960s and 1970s Canadian women entered the work force in large numbers and accounted for well over half of the employment growth in that period. This influx was aided by the buoyant economy of the former decade and then, in the 1970s, by the expansion of the service sector. Now, in the 1980s, there are fears that technological change may erode not only the numbers of jobs available to women but, in particular, their quality. Heather Menzies' grim predictions of 16 to 26 per cent unemployment for female clerical workers in 1985 have not materialized.[1] Our analysis shows, however, that the impacts of the new technologies are far from uniform and that they may adversely affect female employment in certain occupations. Moreover, there are some troublesome accompaniments to technological change – such as increasing part-time work, changes in the skill content of jobs, and the necessity for continuous training – that pose particular problems for female employment.

It is clear that some women are benefiting greatly from the introduction of microelectronic equipment into their work environment. Thanks to this new technology, secretaries can spend less time on routine tasks and assume greater administrative responsibilities; professionals can save time by doing word processing or mathematical calculations on their personal computers; and typists with sufficient technical skills can perform more – and more varied – tasks than hitherto. For women such as these, the new technology has the capacity to enhance the quality of their everyday working life.

For other women, however, the new technology is less attractive. Women in lower-status occupations, such as data entry, are bearing the brunt of the change,[2] along with those in many different fields who would like to work full-time but can only find part-time, temporary, or contract work – a situation that has become increasingly common in the 1980s. And electronic monitoring of the workplace lends a new dimension to the concept of stress.

This chapter is concerned with three major questions. The first relates to technological change and the growth of female employment. We analyse the record of female employment growth in Canada's high-tech sector in the decade 1971-81. Next, we examine women's employment in various occupations and, in particular, the impact of various "structural" factors associated with technological change. Then we consider the prospects for female employment to 1995, with the aid of projections from the MESIM model.

Second, we look not only at numbers of jobs but also at their quality. Are average female earnings (relative to male earnings) higher in the high-tech sector, for example? And what is the situation with respect to part-time work?

Third, how has technological change been implemented in predominantly female work settings? Drawing on case studies, we describe the adaptation process of two groups of women who have undergone three to five years of continuous change in their work environments because of the introduction of new technology.

Structural Change in Female Employment

The composition of the work force is constantly changing. But it has been growth in the female labour force that has represented one of the most notable elements of change in most of the industrialized world over the last 25 years. A 1985 U.N. document noted that women have accounted for more than 60 per cent of labour force growth in Europe and North America since 1960; whereas women accounted for less than 37 per cent of the labour force then, they represented 44 per cent in 1984.[3] In Canada, between 1976 and 1985, the number of working Canadians increased by 1.8 million; women accounted for 70 per cent of that increase.[4] By 1985, 43 per cent of the Canadian labour force was composed of women.

Factors related to this significant increase in female participation in the labour force are numerous. Both labour demand and labour supply have played important roles. On the one hand, the service industries have grown rapidly, from 44 per cent of employment in 1951 to over 66 per cent in 1981. Accompanying service-sector growth has been the growth in female employment. Also associated with rising female employment are declining birth rates and the rising incidence of single-parent families, which are headed mainly by women. Furthermore, women, including those who are married and with children at home, are showing stronger labour-market attachments. The latter is related to educational levels;

better-educated women tend to form a more permanent attachment to the labour force. Last, for many families, the rising cost of living has made two earners a necessity. The net result of those changes has been that the female participation rate – that is, the number of women in the labour force as a proportion of all females aged 15 years and older – increased from 40 per cent in 1971 to 52 per cent in 1981[5] and to 54 per cent in 1985.

Female employment tends to be concentrated in the service sector, notably in education and health; retail trade; accommodation and food; finance, insurance, and real estate; and public administration. In the manufacturing sector, women accounted for a large proportion of employment growth between 1971 and 1981 in the clothing, knitting, textile, and food and beverage industries. Large gains were also made by women in the printing and publishing and the miscellaneous manufacturing industries. In other industries, while growth was less strong, women still made a significant contribution to employment growth over the course of the decade. For present purposes, we especially need to know: Were women making significant gains in the high-tech sector?

Female Employment in High-Tech Industries

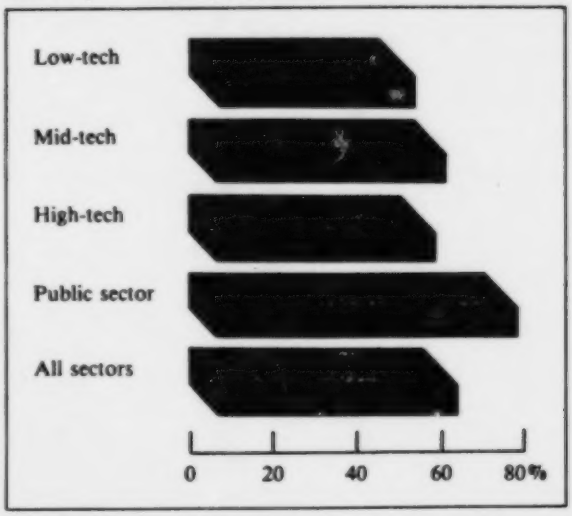
In Chapter 2, industries were identified as being high-, mid-, or low-tech, depending on the extent to which high-tech inputs were used for the production of goods and services. This classification includes only the private business sector of the economy and so excludes government. Since the public sector, broadly defined to include public administration, education, and health and social services, is such a large employer of women, however, we have extended our analysis to include a fourth category – namely, the public sector.[6]

Between 1971 and 1981, the high-tech sector accounted for almost 80 per cent of all job growth in the business sector of the economy. Women fared well in terms of employment growth in high-tech industries, accounting for 51 per cent of the gain (Chart 9-1). The female share of employment growth in the mid-tech sector was also impressive, at 54 per cent. In the low-tech sector, the share of employment growth accounted for by women was 41 per cent. The strongest gain made by women, however, was in the public sector, where the female share of employment growth was 72 per cent.

By 1980, the high-tech sector employed 40 per cent of all women who were working full-time, year-round. The mid-tech sector employed 16 per cent; and the low-tech sector, 9 per cent. The remaining 35 per cent were found in the public sector. Thus it would appear that female performance with regard to employment growth in high-tech industries has been strong. Identifying the shifts in the industry structure of female employment, however, tells only part of the story; also important is the occupational structure of that employment.

Chart 9-1

Women's Share of Employment Growth, by Sector,[1] Canada, 1971-81



1 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top-ranking one-third were considered to be high-tech; the middle one-third, mid-tech; and the lowest one-third, low-tech. This ranking includes only the business sector and so excludes governments. Consequently, a fourth category – the public sector – was added. It includes education and health services; social services; religious organizations; household services; and public administration and other government offices. For more details, see Chapter 2 of this report.

SOURCE Based on data from Statistics Canada, Census of Canada, 1971 and 1981.

Sources of Female Occupational Change

An analysis of occupational employment change was provided in Chapter 3 of this report. There, employment changes over the 1971-81 period for any given occupation were explained in terms of changes in the level and pattern of final demand, in labour productivity, in input mix, and in occupational mix. That analysis may be extended to explain changes in the occupational structure of female employment. In so doing, it becomes necessary to introduce another important source of change – namely, change in the "male/female mix." The latter reflects the fact that female employ-

ment has changed partly because women are assuming a greater (or lesser) share of jobs in any one occupation.

The effect of changes in the level and pattern of final demand showed relatively little variation across occupations. Therefore, most of the differences across occupations in female employment growth can be explained by reference to the two other sources of change. The first consists of changes in the male/female mix. The second, which as a group is referred to as structural change, consists of changes in labour productivity, input mix, and occupational mix. It is through such structural change that the impact of technological change on female employment may be observed.

With the exception of only a single occupation – telephone operators – the contribution of changes in the male/female mix to female employment occupational growth between 1971 and 1981 was positive. Percentage gains in female employment were largest in some traditionally male-dominated occupations, notably in engineering and architecture, draughting, construction trades, and transportation equipment operating. The size of these increases reflect, in large part, the fact that initial female employment in such occupations was small. Nevertheless, the fact remains that women have made important inroads into some traditionally male occupations. In some cases, technological change has acted to reduce physical job requirements, thus opening up new opportunities. In others, the gains reflect the fact that many women are achieving higher educational levels, some in nontraditional fields such as the maths, sciences, and engineering.

In terms of structural change and female occupational employment, there were fewer winners than losers between 1971 and 1981. Of a total of 39 occupational groups, 17 showed a positive impact of structural change (Table 9-1). Among the major winners were electronic data-processing-equipment operators; managerial occupations; social sciences, social workers, law, and library occupations; tellers and cashiers; and system analysts and computer programmers. Among the major losers were sewing machine operators, and electrical and electronic-equipment fabricators. The two worst performers overall were textile processing and resource-related occupations. Those were the only two, in fact, that registered net job losses for women over the period.

A great deal of female employment is found in office-related occupations. While the impact of structural change on those occupations tended to be negative between 1971 and 1981, net employment growth was positive, largely as a result of the contributions made by changes in final demand (Chart 9-2). With the exception of telephone operators, typists and clerk-typists, and secretaries and stenographers, the contributions made by changes in the male/female mix were also large and positive.

Future Employment Prospects

Chapter 4 of this report summarized occupational employment projections to 1995. Using the results of that analysis, it is possible to outline what the future prospects for female employment may be. The MESIM projection model explicitly takes account of the employment effects of computer-based technological change. According to MESIM, those occupational groups which may be expected to experience the largest employment gains include occupations in sales and services, both of which have historically been large employers of women. On the other hand, clerical occupations, which also employ large numbers of women, are expected to experience a substantial net job loss as a result of computer-based technological change to 1995.

Technological change is also having a direct impact on women in the workplace. According to the Working with Technology Survey, the most common types of computer technologies introduced by Canadian establishments between 1980 and 1985 were word processors and personal computers/workstations.[7] And the spread of these technologies is expected to continue to 1990. The predominance of office automation in the 1980s has meant that women, who represent a large proportion of office workers, have, to date, been directly affected by these technologies to a greater extent than men. Indeed, by 1985, close to 16 per cent of all the women, compared with 12 per cent of all the men, employed by respondents to the survey were working with computer technology.

So, not only will technological change force some women to seek employment in new occupations as the number of clerical positions decreases; they will also have to learn how to use the new technologies in the workplace. How technological change has been implemented in predominantly female work settings is described later in this chapter. With regard to the requirement for women to change occupations, we can only suggest that in terms of skill level, the shift from clerical to many sales and service occupations may not be difficult for most women; in individual cases, however, hardship could be in store. And technological change is expected to open up new employment opportunities in managerial, administrative, and related occupations, where gains, as reflected in changes in the male/female mix, have recently been made by women. The scale and nature of adjustment faced by women, therefore, will be affected in part by the extent to which they are successful at entering nontraditional occupations.

Table 9-1

Three Major Sources of Change in Female Occupational Employment, Canada, 1971-81

	Occupations[1]	Sources of change: Structural changes[2] (1)	Sources of change: Male/female mix (2)	Sources of change: Changes in final demand[3] (3)	Net employment change, 1971-81 (1+2+3)
			(Per cent)		
Major winners (from 30.0 to 53.0 per cent)	Electronic data-processing-equipment operators	52.6	7.8	41.6	101.9
	Managerial occupations	45.8	11.8	41.6	99.2
	Social sciences, social work, law, library	38.6	56.7	48.1	143.4
	Tellers and cashiers	33.7	0.8	39.4	73.9
	Systems analysts and computer programmers	31.8	72.3	43.5	147.7
Winners (from 10.0 to 29.9 per cent)	Receptionists and information clerks	28.2	1.7	41.7	71.5
	Bookkeeping and accounting clerks	23.3	18.1	39.5	81.0
	Artistic, recreation, religious	21.5	40.5	46.3	108.4
	Chefs, cooks, waiters, food preparation	16.8	4.4	40.9	62.0
	Engineers and architects	16.6	131.2	43.8	191.5
	Other bookkeeping and account-recording	15.4	10.6	45.6	71.6
	Sales occupations, services	14.2	74.9	45.6	134.6
	Material recording, scheduling, distribution	10.1	37.7	37.6	85.4
Minor winners (from 0.1 to 9.9 per cent)	Draughtspersons	7.3	93.7	45.7	146.7
	Teaching and health-related occupations	6.2	9.6	47.4	63.1
	Lodging, personal, apparel, other services	4.1	11.9	38.5	54.4
	Transport equipment operators	0.3	82.8	37.2	120.4
Minor losers (from −0.1 to −9.9 per cent)	Meat cutting and other food processing	−1.0	27.3	24.1	50.3
	Sales occupations, commodities	−4.5	21.1	35.6	52.1
	Occupations in natural sciences	−7.0	58.5	39.1	90.7
	Secretaries and stenographers	−7.9	1.5	42.7	36.3
Losers (from −10.0 to −29.9 per cent)	Personnel and occupations related to management and administration	−10.7	79.4	44.1	112.7
	Inspecting, testing, grading and sampling	−12.3	7.3	36.9	31.8
	Other manufacturing	−12.9	23.8	38.4	49.2
	Other clerical	−16.5	16.9	42.9	43.1
	Material handling and other crafts, and equipment operators	−16.8	10.1	34.3	27.6
	Construction trades occupations	−18.7	91.0	36.8	108.9
	Accountants, auditors	−19.8	71.7	43.4	95.1
	Foremen of resource, manufacturing, and equipment operating occupations	−20.8	59.3	36.4	74.9
	Labouring and other elemental work	−24.8	21.4	35.0	31.6
	Other reception, mail, messenger services	−25.1	32.6	51.2	58.7

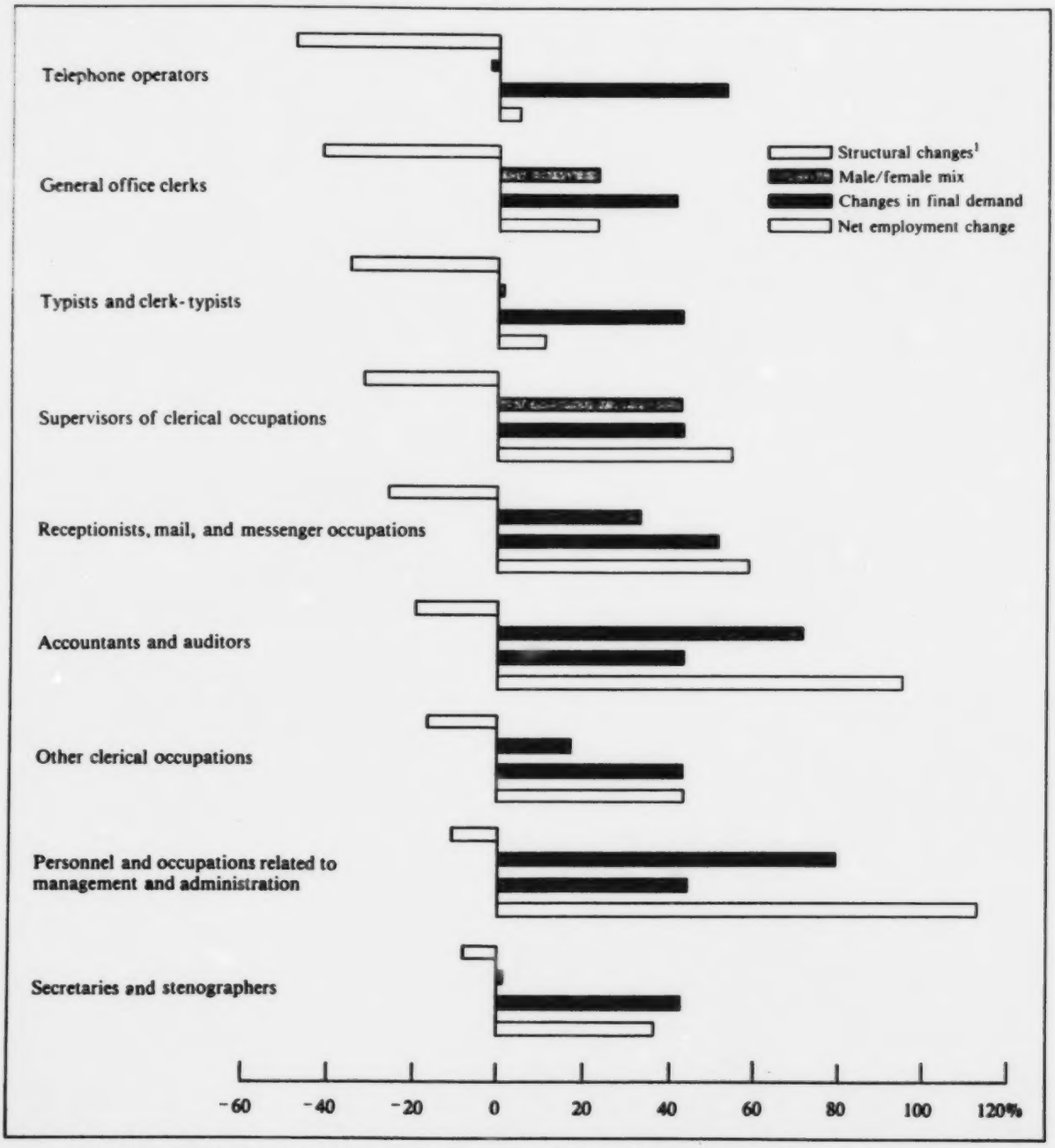
Table 9-1 (concl'd.)

	Occupations[1]	Sources of change: Structural changes[2] (1)	Sources of change: Male/female mix (2)	Sources of change: Changes in final demand[3] (3)	Net employment change, 1971-81 (1 + 2 + 3)
			(Per cent)		
Major losers (from −30 to −58 per cent)	Electrical and electronic equipment fabricating	−30.5	1.7	47.6	18.7
	Supervisors of clerical occupations	−31.1	42.4	43.4	54.7
	Sewing machine operators and textiles	−32.9	8.4	34.8	10.2
	Typists and clerk-typists	−34.3	1.5	43.5	10.6
	Resource-related occupations	−40.7	7.7	24.0	−9.0
	General office clerks	−40.9	23.1	41.7	23.8
	Telephone operators	−46.9	−1.3	53.2	5.0
	Textile processing	−57.1	11.4	36.4	−9.3
Overall change	All occupations	−2.7	15.8	39.1	52.3

1 A detailed list of 85 occupations was aggregated to a total of 39, since female employment in some occupations is extremely low.
2 Structural changes ranked by level of magnitude include: labour productivity, occupational mix, and change in the intermediate demand for inputs. The reader is referred to Chapter 3 for a full explanation.
3 Changes in final demand include those in level and pattern of final demand.
SOURCE Based on data from Statistics Canada, Census of Canada, 1971 and 1981.

Chart 9-2

Sources of Change in Employment of Women in Some Office-Related Occupations, Canada, 1971-81



1 Structural change includes changes in labour productivity, occupational mix, and intermediate demand for inputs. See Chapter 3 of this report for more details.

SOURCE Based on data from Statistics Canada, Census of Canada, 1971 and 1981.

An analysis of the female employment structure shows that women tend to be concentrated in the service sector and in white-collar occupations. Such concentrations of employment are of concern because of a second, related dimension – that of quality of employment. The latter has several aspects: employment income; the nature of employment – specifically, hours worked; and job content. On these counts, concern has been expressed that women are not sharing as fully as men in the benefits associated with work.

Employment Income

While the high-tech sector offered women more employment opportunities than any other sector in 1980, the earnings gap between men and women in that sector was nevertheless significant. On average, for all industries, women's earnings were 64 per cent of men's earnings in 1980. Within the high-tech sector, in only four of the 13 industries was the ratio of female/male earnings higher than the national average (Chart 9-3).

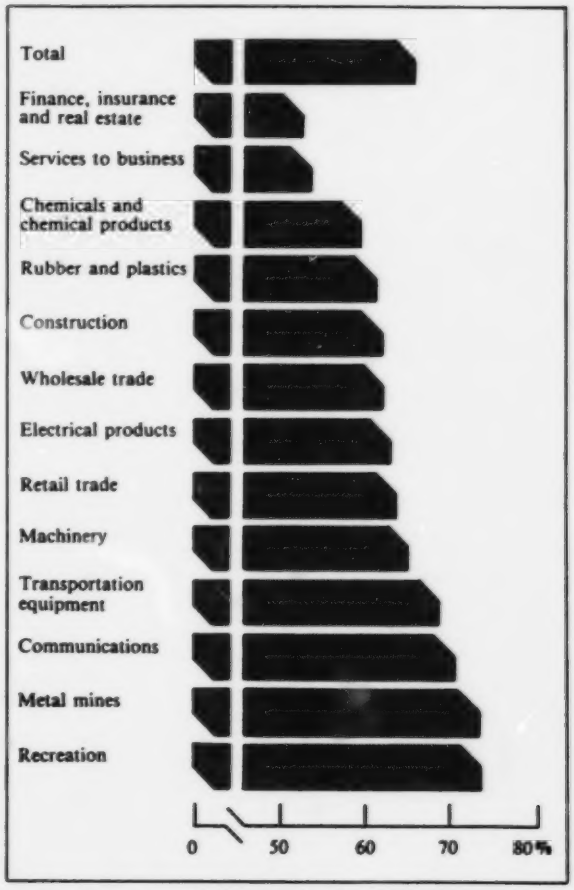
In terms of occupational structure, 36 per cent of women were employed in clerical occupations in 1980. For women in those occupations, employment income was not a function of the level of technology used by an industry. As shown in Table 9-2, female clerical workers in high-tech industries did not necessarily earn the highest average incomes; on the contrary, with the exception of tellers and cashiers, and receptionists and information clerks, female clerical workers in the high-tech sector had lower average incomes than their counterparts in the low- and mid-tech sectors. In other words, merely being employed in the high-tech sector was no guarantee that on at least one important dimension of employment quality – namely, employment income – women would fare well.

Part of the explanation for the gap between female earnings and male earnings arises, of course, out of the occupational structure of female employment. Women tend to be concentrated in clerical, sales, and service occupations (Chart 9-4). Jobs in those fields are characterized by low pay, high turnover, and low union penetration.[8] Furthermore, more female employment is found in the high-tech sector than in the mid- and low-tech sectors and in the public sector. The high-tech sector typically is highly volatile; it comprises many small companies, whose birth rates and death rates are high.[9] As a result, many employees do not enjoy job security and do not have continuous employment that would enable them to acquire the experience and seniority that command higher wages.

Many observers have expressed concern over the occupational structure of female employment and the earnings associated with that structure. These concerns

Chart 9-3

Female/Male Ratio of Employment Income[1] in High-Tech Industries,[2] Canada, 1980



1 For those who worked full-time/full-year in 1980.
2 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top-ranking one-third were considered to be high-tech. For more details, see Chapter 2 of this report.
SOURCE Based on data from Statistics Canada, Census of Canada, 1981.

are further compounded by another recent trend in the quality of female employment, which is indirectly associated with technological change – namely, the growth in part-time work.

Part-Time Work

A crucial dimension of job quality is the hours worked. The pros and cons of part-time work are dis-

Table 9-2

Average Female Employment Income,[1] by Clerical Occupation and Technological Sector,[2] Canada, 1980

	Low-tech		Mid-tech		High-tech	
	Number	Average income	Number	Average income	Number	Average income
		(Dollars)		(Dollars)		(Dollars)
Clerical occupations:						
Secretaries and stenographers	14,980	13,422	23,215	13,061	95,365	12,440
Typists and clerk typists	3,755	12,420	3,905	11,998	21,750	11,353
Bookkeepers	20,170	12,915	24,805	12,550	103,085	12,319
Tellers and cashiers	830	12,027	4,915	8,543	51,150	10,394
Other bookkeeping and accounting clerks	595	13,315	700	12,899	26,120	12,498
Electronic data-processing operators	4,035	13,182	3,670	13,190	20,075	12,367
Receptionists and information clerks	2,430	11,548	4,460	10,495	12,365	11,020

1 That is, average income of women who worked full-time/full-year in 1980.
2 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top-ranking one-third were considered to be high-tech; the middle one-third, mid-tech; and the lowest one-third, low-tech. The ranking includes only the business sector and so excludes governments. For more details, see Chapter 2 of this report.
SOURCE Based on data from Statistics Canada, Census of Canada, 1981.

cussed in Chapter 7. While acknowledging the advantages of flexibility afforded both employers and employees, we draw special attention, here, to some of the difficulties that it poses for women. Generally speaking, part-time work is less remunerative than full-time work; it offers fewer benefits in terms of protection and pension funds; and it often excludes workers from collective agreements.[10] Also, seniority is built more slowly, since time worked is less. While the majority of female part-time workers prefer that type of work for many reasons, there is an increasing number of women who work part-time because they cannot find full-time work.

Since 1976, women have accounted for over 70 per cent of all part-time workers. And the proportion of women who are working part-time is growing; it rose from 21 per cent in 1976 to 26 per cent in 1985.[11] While the 1981 recession and post-recession adjustments made by firms have certainly contributed to growth in part-time employment, some of it may have resulted indirectly from technological change.[12]

Technological change can facilitate part-time work in two ways. On the one hand, in contributing to productivity growth, the number of workers required may be reduced. Some businesses have responded to that by reducing the number of full-time positions and increasing the number of part-time positions. Examples of technological changes associated with this source of growth in part-time work are automated teller machines, electronic cash registers, and electronic communication of data.[13] On the other hand, some of the new technologies can facilitate the adoption of new work arrangements. These include, for example, working from the home, where remuneration is based on the volume of work produced, the number of forms processed, or the number of hours logged on word processors or home terminals.

Growth in part-time employment is particularly evident in three traditionally female occupations: clerical, services, and sales[14] (Chart 9-5). Furthermore, a growing proportion of female part-time employment in these occupations has been of an involuntary nature, especially since 1982 (Chart 9-6). In other words, a growing proportion of women who are working part-time would choose to work full-time. In 1985, involuntary part-time work for clerical and sales workers represented 26 per cent of all part-time female workers in those occupations. In service occupations, 33 per cent of female part-timers worked part-time involuntarily. While sales and service occupations have always had high proportions of part-time workers, this has not been the case for clerical workers until now.

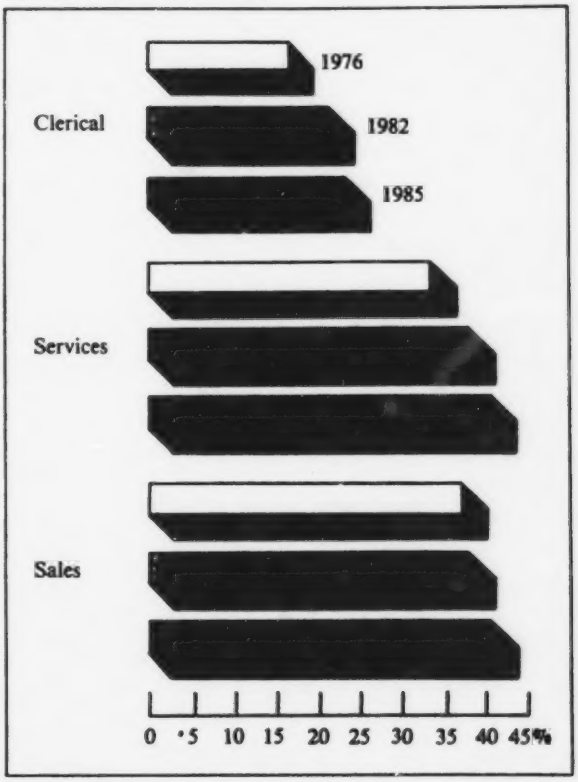
Chart 9-4

Total Female Employment, by Occupation, Canada, 1976 and 1985

1 This group includes nursing and teaching occupations.
SOURCE C. Dumas, "Occupational trends among women in Canada: 1976 to 1985," Statistics Canada, *The Labour Force*, Cat. 71-001, October 1986.

Chart 9-5

Female Employment: Part-Time as a Proportion of Total, Canada, 1976, 1982, and 1985



SOURCE Based on data from Statistics Canada, Labour Force Survey.

Similarly, female part-time employment is heavily concentrated in three industries: trade; finance, insurance, and real estate; and community, business, and personal services (Chart 9-7). And the proportion of female employment that is part-time in those industries, particularly in the latter two, has been growing steadily since 1976.[15] Furthermore, in all three industries, the proportion of part-time female employment that is "involuntary" in nature has been growing even more rapidly (Chart 9-8).

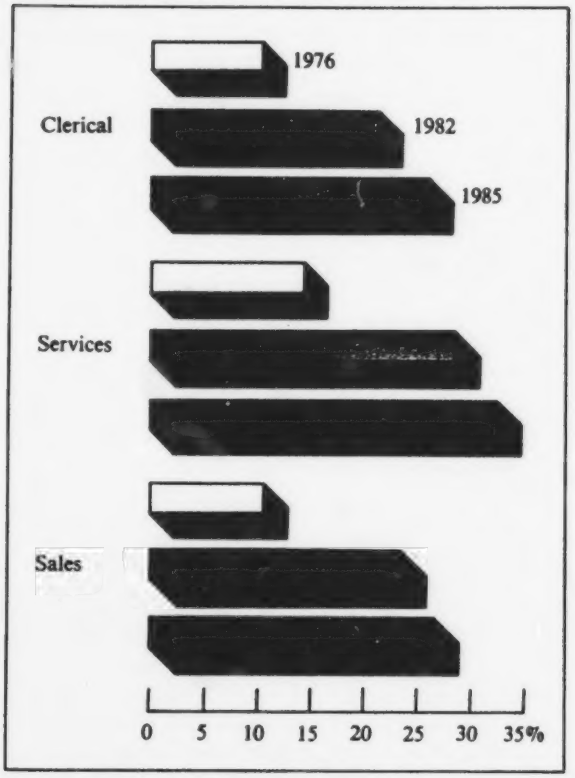
It is clear, therefore, that while employment opportunities for women are growing, many of these offer only part-time work. And a growing proportion of women are accepting this part-time work, but involuntarily. If given the opportunity, many women would choose to work full-time.

Innovation in Female Work Settings

The detailed effects of technological change in the workplace can best be understood through case studies. For this reason, the Economic Council conducted a series of in-depth analyses of innovative organizations in Canada. Two of these focused on technological change in settings with a heavy concentration of female workers. In this section we review those cases to consider the innovation process and its impacts on the women involved. Naturally, the generalizability of these cases is limited; nevertheless, they illustrate interesting aspects of adjustment to new technologies in predominantly female workplaces.

Chart 9-6

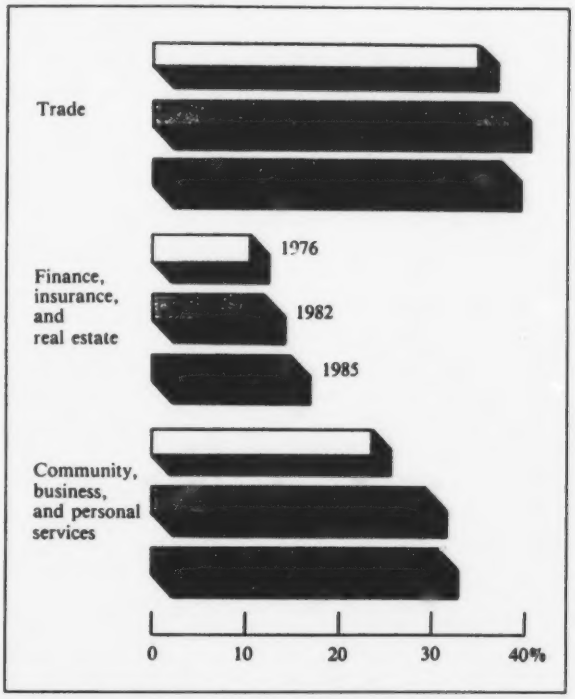
Female Part-Time Employment: "Involuntary" as a Proportion of Total, Canada, 1976, 1982, and 1985



SOURCE Based on data from Statistics Canada, Labour Force Survey.

Chart 9-7

Female Part-Time Workers in Three Industrial Sectors, Canada, 1976, 1982, and 1985



SOURCE Based on data from Statistics Canada, Labour Force Survey.

Both of these studies pertain to organizations in the federal public service, which is the largest single employer of women in the country. Over the last 10 years, females working full-time here have increased their share of total employment from 35 per cent to 40 per cent.[16] Many of these women work in settings typical of female employment in general – in clerical and related occupations, carrying out office, information, and other service functions.

Staffing cutbacks designed to reduce government expenditures have had an effect on the size and type of jobs in the federal public service in the last few years. Total employment has decreased, and "contract" or "term" employment has grown in relative terms. The latter accounted for 10 per cent of total employment in 1985, while it had remained stable at 6 per cent from 1976 to 1980.[17]

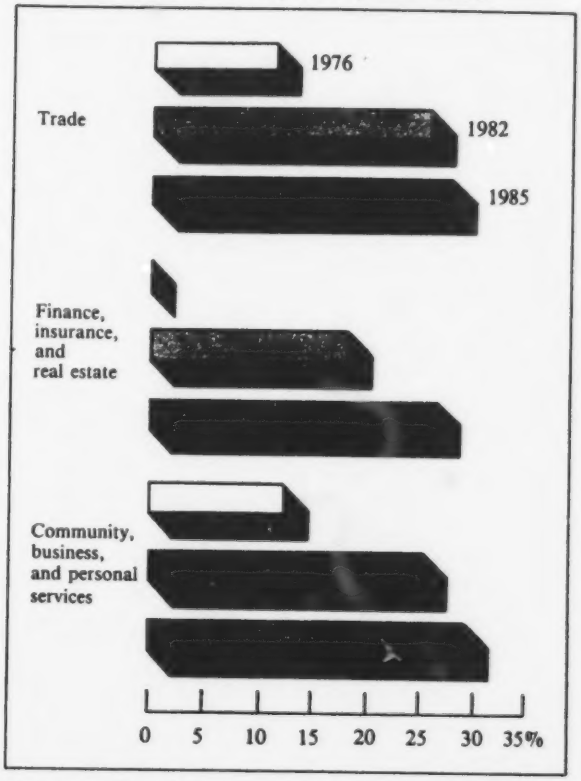
Throughout the federal public service, new technologies are being introduced to improve and rationalize services. The cases we have examined involve organizations within Employment and Immigration Canada and Statistics Canada. In both situations, technological change reduced the number of required positions, and in both, adjustment strategies to avoid layoffs were pursued. As we shall see, however, the approaches to innovation were quite dissimilar, reflecting the different circumstances in which the technological changes took place.

Employment and Immigration Canada – A Case Study

The organization studied within this department administers unemployment insurance applications and benefits in the province of Quebec. A large and complex system is required to carry out this function, with a regional headquarters, several local employment cen-

Chart 9-8

Female Part-Time Employment in Three Industrial Sectors: "Involuntary" as a Proportion of Total, Canada, 1976, 1982, and 1985



SOURCE Based on data from Statistics Canada, Labour Force Survey.

tres, and over 2,000 workers. Information flows, within this network and between the bureaucracy and its clientele, are essential for effective service.

The case study focused on the on-line computerization of this service and its effect on clerical workers. This new technology – the Insurance On-Line System (IOLS) – enables applications for unemployment insurance to be processed on-line, with information communicated over phone lines. Recipients' files are updated on a daily basis via a VDT linked to the main computer. The system offers many advantages. Applications for benefits are handled more quickly; unemployment insurance agents have direct access to files, which reduces waiting time; and recipients are able to get information through the on-line system on the employment situation in other parts of the region or in neighbouring areas. Finally, the system allows greater control over the unemployment insurance fund.

Human Resource Impacts

The introduction of IOLS has had some widespread effects. While the content of clerical work has remained much the same, work methods have changed for some employees. These changes have most affected those occupations involving information, filing, data processing, and other clerical duties. On clerks' desks, VDTs have taken the place of pens and pencils. There are some new duties, such as system maintenance and coordination, that involve technical skills. The central transmission of transactions is the only new duty that has been assumed by clerical staff. Aside from this, the essential nature of the work has not changed, and, accordingly, clerical positions have remained at the same classification level.

The new system does, however, require fewer workers, and with position cuts expected,[18] it has been the cause of much concern among employees. In preparation for the changes, the department had instituted a systematic adjustment strategy. This strategy included consultation with the union from the beginning, as well as preliminary studies on the impact of IOLS.

The adjustment strategy taken was to ensure that no "permanent" jobs would be lost; clearly, "contract" positions were to bear the brunt of technological change. Across the province, the budgets for temporary employees and overtime work during peak periods were eliminated. In the majority of cases, these workers were women or students.

The situation was somewhat different and more complex at the central office – the Regional Computer Centre. More than half of the planned reduction was to be accomplished by simply letting temporary employee contracts lapse. The total cuts could not be made solely by eliminating those workers, however. Accordingly, some clerical positions involving data control, entry, and data management were eliminated, and most of those jobs had been occupied by female keypunch operators. The sections slated for expansion included computer-network control, software development, and advanced console operation. Few women in the sections where cuts were to be made had the necessary technical background to move into these higher positions. For them, the "no-layoff" policy was maintained through attrition and especially through transfers elsewhere in the organization.

Statistics Canada – A Case Study

The second study examined the experience of a division of Statistics Canada responsible for preparing

publications. This was a small division of Statistics Canada with less than 200 employees, all situated in one location. Innovation here was incremental: over the 1983-86 period, sophisticated electronic publishing equipment was introduced that transformed the production process. These changes allowed the division to improve its service, as well as the quality and quantity of the work it produced.

Human Resource Impacts

The new production methods brought profound changes to the Publications Division. As electronic publishing evolved, the duties and responsibilities of the operators changed. Major skill upgrading was required to transform the existing personnel – mostly word-processor operators – into specialized technicians. Between 1983 and 1986, several training courses were organized, as new machines were brought in when management felt that better equipment was available. Knowledge of computers and design techniques became more important than the simple typing skills of the pre-electronic era. In this case, the tools of work had changed, becoming much more sophisticated as new duties were added.

The process of adjusting to these new technologies was handled by management without the systematic framework developed in the Employment and Immigration case. Apparently, the union was not involved per se: meetings were held, but technological change does not seem to have been discussed. With respect to meeting the new skill requirements, training was provided as needed.

The new technologies did require some position cuts. It should be noted that throughout the period when these changes were taking place, Statistics Canada was experiencing staff and budget reductions. At the same time, the division's mandate was changed, which created a further surplus of word-processor operators. These developments, then, aggravated the adjustment task called for by the technological changes. The agency's policy was to relocate personnel where possible, and about 15 per cent of the original number of workers in the Publications Division were absorbed by other divisions. As in the Employment and Immigration case, temporary contracts were allowed to lapse, and normal attrition took up the slack.

Adjusting to Technological Change

The two case studies illustrate quite different approaches to technological change. Undoubtedly, these reflect the vastly different scopes of the projects. As we have noted, one change affected over 2,000 employees, scattered in 90 regional offices, while the second altered the work environment of about 200 persons, located in a single division and location. Each approach had its own characteristics. Strategic planning, pilot projects, preliminary impact studies, meetings with union representatives, and customized training programs were the key elements of the first case. Evidently, this systematic approach was required for change of the scale that the IOLS represented. The second case, involving a much smaller organization with more incremental innovation, took a less formal approach. Adjustments were made as necessary, with both management and staff "learning by doing." There were some common elements, however, in the approach to change. While unions were consulted in the Employment and Immigration case, all decisions in the reorganization of work seem to have come from management in both situations. And, most notably, a "no-layoff" policy for permanent employees was followed by each organization.

In terms of skills, the introduction of new technologies in both cases had either a neutral or an upgrading effect. This was particularly true of those women who remained in the modernized publications division of Statistics Canada. From a word-processing pool, this unit was reorganized into semi-autonomous production modules. Each module is responsible for its work scheduling, from early design to end product. Direct contact with authors of published documents, internal quality circles, as well as rotation between modules, have brought diversity to the work. This, of course, helps in broadening experience on different microelectronic equipment. The professional mobility for the women in the division has been enhanced considerably. Complexity of the work and technical skills have been re-evaluated by personnel management, and positions have been reclassified at higher levels.

While the skill effects for the relocated employees at Statistics Canada and for the women at Employment and Immigration have not been of the same magnitude, there was no evidence of deskilling. The persons relocated at Employment and Immigration, for example, were satisfied with the change, since it enabled them to move from a dead-end type of position as the data entry function became less important into a more challenging area offering future advancement. While in our own case studies, we did not find evidence of technological change deskilling women, other inquiries have. For example, a study looking at the automation of the accounting department of a forestry company in British Columbia concluded that while better-educated clerks were upgraded, junior clerks experienced the opposite effect.[19]

Further insights into the effects of innovation were obtained through a survey of 70 women in the two

organizations. It should be noted that the respondents represented two common situations facing employees in technological-change settings: first, some were using the new technology after receiving retraining; and, second, some were relocated because the new technologies made them redundant. An important third group – those who lost their temporary or contract jobs as a result of innovation – could not be captured in the survey.[20] Characteristics of the respondents are summarized in Figure 9-1.

The survey results indicate that, overall, job satisfaction has been fairly high. Many respondents noted that innovation had enhanced the "interesting nature of the work" and the "opportunity to make full use of abilities and skills." Most respondents felt that "control over work scheduling" was good after the change, but a small proportion felt it had deteriorated. Globally, for these three job-content measures, the majority of women were satisfied with technological changes and the resulting relocation for some.[21]

A fourth component of job satisfaction – "opportunities for promotion" – brought more controversial results. Half of those working with the new technology in the Publications Division felt such opportunities did not exist before or after the change. Most of those relocated with a higher job status ranked this aspect highly, while the ones laterally transferred (with the same status) felt very negative about it. Clearly, higher status (with better pay) comes with job re-evaluation, not with technology. Clerical employees in the survey felt that technology is now an established fact. They said they had to learn it in order to keep their jobs but could not rely on it for promotion. Finally, while technological change has often been cited as an isolating factor, our results do not support this. The survey responses show that it did not modify the respondents' "contacts with other employees"; the majority felt such contact remained good.

The skill and job-satisfaction effects of the technological changes in our cases, then, were favourable for those who remained. An important part of the story, however, concerns the temporary workers, who bore the brunt of the downsizing in both cases. No-layoff policies for full-time employees is, in our view, a desirable human resource strategy; however, they heighten the job insecurity of those outside the protected staff. Unprotected contract workers occupy a growing proportion of employment in the federal public service, and elsewhere. Many, if not most, of these workers are women, which raises concerns for the impact of technological change on the female labour force.

Implications for Training and Education

As demonstrated in our case studies, employees faced with technological change have to learn how to operate new equipment or be transferred to other positions if they wish to keep their jobs. But women whose job skills have been made obsolete by new technologies, whether they have previously lost their jobs or are just now returning to the labour market, face particular difficulties. Do women who sign up for federal-government-sponsored training programs opt for fields of study leading to new opportunities?

Boothby recently completed a study of women taking those courses.[22] One of his findings was that course choices were strongly influenced by previous jobs. He

Figure 9-1

Case Studies of Women and Office Automation: Characteristics of Survey Respondents, 1986

Characteristics	Pertinent details
Age	71 per cent were between 20 and 40 years
	34 per cent – 20-29 37 per cent – 30-39
Education	53 per cent had high school education; 24 per cent had some postsecondary studies
Work experience (with present employer)	70 per cent had between 6 and 20 years
Training (on-the-job)	67 per cent had some training during previous two years
Average annual salary	81 per cent in $17,700-to-$28,000 range

Source: Based on data from Economic Council of Canada, case studies of the introduction of microelectronics equipment in the federal public service, 1986.

shows how these choices made sense, considering the amount of time and training already invested by these women in their careers. Another study looked at the subject from a somewhat different perspective.[23] Its hypothesis was as follows: the fact that more men than women participate in federal-government training programs, particularly in fields considered nontraditional for women, is because courses were being aimed primarily at reintegrating unemployed workers from secondary industries (manufacturing, repair, mechanical, and related occupations). The study pointed out, however, that 1976-85 was a period of decline for those industries. Considering that occupations in the secondary industries are also threatened by automation, does it make sense to continue training people to work in those fields? Computer knowledge, communication, and advanced office automation represent areas of growth that are in the vanguard of technological change. Training for the unemployed, both inside and outside the workplace, should be aimed more at developing general skills in order to maintain as wide a range of opportunities as possible. And what about the young generation entering the labour market now? How well prepared are they to face the changing scene?

Educational Background of Canadian Women

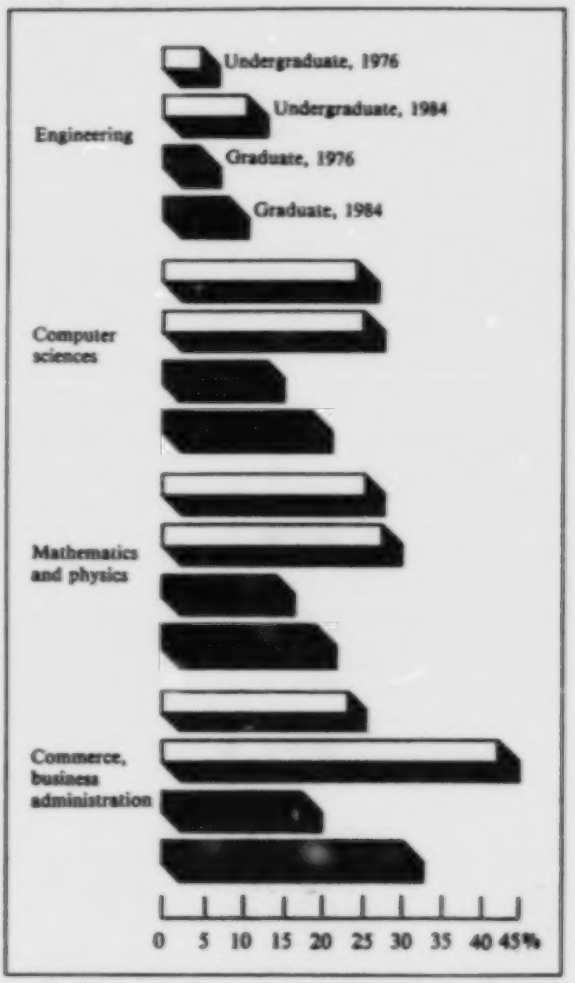
Canadian women have made excellent progress in achieving higher levels of education. Chart 9-9 shows, in percentage terms, the growth in women's full-time enrolment in some university programs over the period 1976-84. The labour market has been slow to respond to these changes, however. Chart 9-10 shows the percentage distribution of male and female workers in the managerial and professional occupations in 1976 and in 1985. While clear improvement can be seen in one formerly male-dominated occupation (managerial and administrative occupations) – with women accounting for 32 per cent in 1985 compared with 20 per cent in 1976 – science and engineering still has a relatively low percentage of women (16 per cent) but, again, higher in 1985 than in 1976.

Until quite recently, women tended not to pursue their education past the bachelor-degree level. Though still vastly outnumbered in postgraduate studies, women are making progress at that level as well. The increased representation of women at the postgraduate level in business and commerce, for example – from 17 per cent in 1976 to 30 per cent in 1984 – is undoubtedly part of the reason for the success that women have enjoyed in that occupational field. It is still true, however, that the majority of women studying at the postgraduate level opt for traditionally female disciplines, such as social sciences and education. But according to a national survey of 1982 graduates, the areas of study that offered the best chances of getting a full-time job (with its attendant higher wages and better benefits) were those with direct or indirect ties to science and business administration.[24]

The same survey also confirms that employment earnings rise with a higher educational background. The median annual earnings for a full-time job in 1984

Chart 9-9

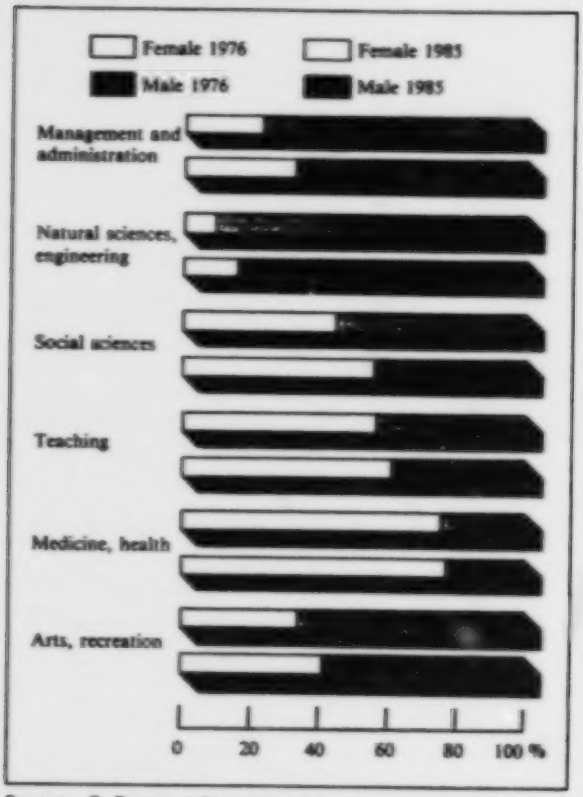
Women as a Proportion of Full-Time University Enrolment, Selected Disciplines, Canada, 1976 and 1984



SOURCE C. Dumas, "Occupational trends among women in Canada: 1976 to 1985," Statistics Canada, *The Labour Force*, Cat. 71-001, October 1986.

Chart 9-10

Managerial and Professional Employment, by Sex, Canada, 1976 and 1985



SOURCE C. Dumas, "Occupational trends among women in Canada: 1976 to 1985," Statistics Canada, *The Labour Force*, Cat. 71-001, October 1986.

ranged from $15,000 for graduates of trade and vocational schools to $34,000 for holders of Ph.Ds. But the male/female-earnings gap nevertheless persists; women were paid $2,000 to $5,000 less than men with the same qualifications. Because it was unclear whether this comparison took account of other variables such as work experience or industrial and occupational distribution, it was not conclusive.

Conclusion

Structural and technological changes have contributed to the modification of the labour-market scene for women in some groups of occupations. Sectors where they entered massively over the 1970s were among the first to automate in the 1980s. The high-tech sector had the largest proportion of women employed in 1980, but female earnings there, relative to male earnings, were lower than the national average in most cases. Highly concentrated in clerical jobs, women in high-tech received lower employment income than their female counterparts in less technologically developed sectors.

Recent developments show some job-quality deterioration for women in terms of hours worked. Occupations with traditionally high proportions of female part-time workers, such as services and sales, have experienced an increase in the numbers of part-time female workers. There has also been a significant increase in part-time employment in clerical occupations since 1981. There are some indications that the traditionally stable and unionized sectors are not hiring as many clerical workers as before. This results in women who are looking for clerical jobs having to move into sectors where job security is lower and where part-time work is more prevalent. And if a growing proportion of women are having to accept part-time work, more of them are missing out on the benefits attached to full-time jobs. This is especially true for pension funds, through which higher security for working women could be attained. If part-time work is to grow in the future world of work, special attention should be given to appropriate legislation that will reflect this situation and protect workers accordingly.

Stemming from our case studies in the federal public sector, we have seen that for those who have permanent jobs it is possible to adapt to new technologies. Contract employees are the first to pay the cost of technological innovations. Such contract employment accounts for an increasing share of new openings in the federal public service, so that, in conjunction with the normal attrition process, it is becoming more and more difficult for women at the lower levels of clerical occupations to enter permanent jobs.

The cases show that in the process of adapting to technological change the better-educated and higher-skilled women stand the best chance of benefiting, though even at lower-skill levels new technologies may bring more challenging and less monotonous jobs. As far as job satisfaction with technological change is concerned, it is no surprise to learn that improvements in skill content, classification, and earnings figured positively, while those women who were unwilling, or unable, to operate the new equipment, or who were relocated with no change in status, were less satisfied. Of special interest, however, is the fact that satisfaction with training was an important element in successful adjustment.

Although higher education levels are being attained by more women in Canada than was the case some years

ago, the occupational structure of the labour market is only slowly reflecting those gains. Gains have been made in management and administrative occupations, but in other professional fields, female representation remains low. For the heavy concentration of women in clerical occupations, employment has been slowly shifting toward the more volatile sectors of the economy. The growing importance of part-time work (especially of the "involuntary" type) is disquieting and should receive serious consideration. Similarly, basic education and training programs will have to widen the scope of technical courses and apprenticeship, to provide smoother adjustment mechanisms for women displaced by structural changes.

10 Special Groups and Technological Change

Not all workers face the same likelihood of labour market problems. Historically, youth, older workers, Native peoples, and the disabled have experienced more than their share of difficulties. For some, these have come in the form of frequent and lengthy periods of unemployment; for others, low and sporadic participation in the labour force; and for still others, low-skill, low-wage occupations.

The early chapters in this report dealt with the employment effects of technological change. Although views differ as to the net effect of new technologies, there is consensus that the impact has not been, and will not be, uniform. Some industries and occupations have fared better than others, and such unevenness will continue in the future. Chapters 2, 3, and 4 make this point quite clearly. The question raised in the present chapter is whether the character of special groups and their particular employment patterns are such that the effects of technological change and, in particular, its differential impact across sectors fall more heavily on the shoulders of special-group members.

This chapter is divided into five sections. It begins with a brief description of the persons who are included in special groups and indicates the problems they have traditionally encountered. Against this background, we look at the concentration of special groups in certain industries and ask whether, compared with the general population, their particular industry configuration has implied a greater risk of dislocation as a result of technological change. In section three, attention is directed toward the occupations typically taken up by special groups. Are they occupations that hold promise for the future or is their continued existence being challenged by the introduction of new technologies? In section four, we look at the education profile of special groups and examine what forces have acted on jobs characterized by their education levels. Finally, we focus specifically on the disabled – the group that potentially may have the most to gain from technological advancement.

Special Groups – Who Are They?

Individuals identifying themselves as Native people in the 1981 Census numbered about 491,000. This represented about 2 per cent of the total Canadian population, but they were significantly more concentrated in specific regions – especially the North and the West. They have found it increasingly difficult to provide for their needs through traditional economic activities, through alternate employment in Native communities, or even in the surrounding region. In an attempt to improve their living standards, many have moved off the reserves and into towns and major urban centres. But the Native population has a very different demographic composition, education and skill levels, and employment experiences than the non-Native population. Historical failure of the job market to meet their needs has led to very high unemployment rates (2.2 times the national rate in 1981), lengthy periods of unemployment, and participation rates significantly lower than those of the general population.

In a recent (1983-84) Statistics Canada survey, 2.4 million adults reported some level of disability (12.8 per cent of the Canadian population over age 15). These persons were further classified as to degree of disability: 14 per cent were deemed to have major disability; 23 per cent, moderate disability; and 54 per cent, some disability.[1] Two-thirds of the adult problems pertained to mobility or body movements; 15 per cent, to hearing; and 8 per cent, to eyesight. The range of problems faced by the disabled in the labour market has been greater than for other special groups. Not only have they experienced problems created by their inability to perform certain types of work; they have also had to cope with public perceptions (often inaccurate) of the extent of their limitations. The workplace often puts unnecessary physical requirements on its employees and, in the past, has often failed to provide compensating accommodation for the disabled. Finally, the training, education, and even work aspirations of the disabled have been hindered by lack of encouragement. The "real" problems and the "created" problems have translated into low participation rates (52.2 per cent of disabled are not in the labour force compared with 25.1 per cent of the nondisabled) and correspondingly low employment rates (41.5 per cent of adult disabled are employed compared with 67.4 per cent of the adult nondisabled).

Youths (aged 15 to 24) represent about 23 per cent of the labour force. Their share grew rapidly until recent years, and that rapid growth brought with it a youth unemployment rate consistently higher than the adult rate. As growth in this segment of the labour force moderates, unemployment may become less of a problem for the group as a whole.[2] Those for whom it

could remain a problem, however, are the very young (15 to 19 years). They constitute about 8 per cent of the labour force and have greater difficulty in finding a job, are more susceptible to layoff, and experience longer bouts of unemployment, because they lack the educational or vocational credentials necessary to make them attractive to employers.[3]

Older workers (aged 45 to 64) represent about 24 per cent of the labour force. Their unemployment rate has been lower than average, but when they do lose their jobs, they face long spells of unemployment and are more likely to withdraw from the labour force in discouragement. Their traditional problems stem from low occupational mobility, limited opportunities for retraining, weaker educational background, and employer preference for younger workers.

Industry Employment Patterns of Special Groups

Although youth, older workers, and Natives are found in all industries, each group has its own distinctive distribution across industries. Table 10-1 indicates the industries in which various groups are concentrated. The table is at a fairly aggregate level and masks some of the greater differences that appear at a finer level of industrial detail. The industrial distribution of the very young members of the labour force (15 to 19 years) differs most strikingly from that of the other age groups. They are employed more heavily in retail trade (nearly double the share of the 25-64 age group) and somewhat more heavily in services. Accommodation and food services, and amusement and recreation services, employ 20 per cent of the very young, compared with 5 per cent of the 25-64 age group.

Compared with the non-Native population, employment of Native people is more concentrated in the primary industries (especially forestry, fishing, and mining), construction, and public administration. They are under-represented in manufacturing and services, and when they are found in these sectors, they are concentrated in resource-related activities (fish processing, sawmills, pulp and paper mills) and in tourism (hotel and motel services, and recreation services). Their employment patterns continue to reflect traditional ways of life, but at the same time they also reflect recent developments. Their concentration in public administration, for example, illustrates the shift in program responsibility and implementation from various federal government departments to local band councils and other community-based organizations. It also captures the increasing proportion of employment derived from short-term, federally sponsored job-creation programs, such as Canada Works, and various work and training schemes.[4]

In Chapter 2, industries were classified as high-, mid-, or low-tech, according to the share of high-tech inputs in their total non-labour inputs. On balance, it was found that in 1981, 53 per cent of all employees were in high-tech industries; 34 per cent, in mid-tech industries; and 13 per cent, in low-tech industries. Table 10-2 shows that representation of the various groups in the high-tech sector was fairly close to average in 1981. Those aged 20 to 24 years had the highest share (56.4 per cent), while Native peoples and workers aged 65 and over had the lowest shares (49.5 and 45.7 per cent, respectively).

In Chapter 3, the impact of changes in final demand and of changes in technology[5] (as measured by changes in labour productivity and changes in demand for intermediate inputs) on employment were shown to vary considerably from industry to industry. That analysis can be extended to include consideration of employment change for different age groups. To do so, it becomes necessary to add an additional source of change in employment patterns – namely, change in the "age mix."

Over time, the number of workers in any given age group will change as a result of the aging of the population. As time passes, the 15-19-year-olds will leave the lowest age group and shift into the 20-24 age group. Also with the passage of time, older workers move into still older age groups and on out of the labour force into retirement. Each and every age group is in a constant state of flux, with people moving into and out of it. At any point in time, the pattern of employment across age groups is called the age mix. The change in the number of jobs held by a given age group will partly reflect changes in this age mix. It should be noted that the age mix is demographically determined and is quite distinct from employment change derived from technological change and final demand change.

The mix of the labour force has shifted from older to younger workers (Table 10-3). Employment shifts resulting from changes in the age mix have been positive for the younger groups and negative for the three older groups. The impact varies from a 3 per cent increase in employment for 15-19-year-olds to a reduction of 17 per cent in potential employment for the over-65-year-olds.

With respect to labour productivity change, age groups have distributed themselves over industries such that the very young (15 to 19 years) have a slight advantage with respect to displacement. The 15-19 age group experienced a reduction of 4.8 per cent compared with

Table 10-1

Industrial Distribution of Age Groups and of Native People, Canada, 1981[1]

	Age group (years)					Ethnic origin	
	15-19	20-24	25-44	45-64	65 +	Native	Non-Native
	(Per cent)						
Industry:							
Primary	7.4	6.2	6.3	8.1	19.0	12.1	7.1
Manufacturing	14.0	20.1	19.3	20.4	10.9	15.0	19.2
Construction	4.7	6.3	6.5	6.3	4.1	9.0	6.4
Transportation, communications, and utilities	3.8	7.7	8.8	9.2	3.8	7.1	8.1
Trade	29.2	18.8	14.8	15.9	18.3	10.5	16.9
Finance, insurance, and real estate	3.4	6.8	5.9	4.6	6.3	2.2	5.4
Services	33.2	26.9	30.0	27.3	33.1	27.4	29.3
Public administration	4.3	7.1	8.4	8.2	4.4	16.7	7.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1 Data on age groups relate to the industrial distribution of the employed labour force; data on ethnic origin relate to the industrial distribution of the experienced labour force.

SOURCE Based on data from Statistics Canada, Census of Canada, 1981.

Table 10-2

Distribution of Age Groups and of Native People, by Technological Sector, Canada, 1981[1]

	Age group (years)					Ethnic origin	
	15-19	20-24	25-44	45-64	65 +	Native	Non-Native
	(Per cent)						
Technological sector:[2]							
High-tech	52.6	56.4	53.6	50.5	45.7	49.5	52.8
Mid-tech	36.7	29.7	33.2	35.6	45.7	33.3	33.8
Low-tech	10.7	13.9	13.2	13.9	8.6	17.2	13.4

1 Data on age groups relate to the distribution of the employed labour force; data on ethnic origin relate to the distribution of the experienced labour force.

2 Industries were ranked according to the extent to which high-tech inputs were used for the production of goods and services. The top-ranking one-third were considered to be high-tech; the middle one-third, mid-tech; and the lowest one-third, low-tech. This ranking includes only the business sector and so excludes governments. For more details, see Chapter 2 of this report.

SOURCE Based on data from Statistics Canada, Census of Canada, 1981.

the average of 10.1 per cent. They tend to be found in industries with lower rates of productivity growth.

Shifting demand for intermediate inputs has had marginally different impacts, with the 15-19 age group gaining the least number of jobs (0.7 per cent) and the 20-24 and the over-65 age groups gaining the most (3.0 per cent). By combining the changes caused by labour productivity and intermediate demand, we get a measure of the impact of technological change. The

Table 10-3

Sources of Employment Change, by Age Group, Canada, 1971-81

	Change in employment, 1971-81 (1)	Change in employment because of change in:						
		Age mix[1] (2)	Technology			Final demand		
			Total (3)	Labour productivity (4)	Intermediate demand (5)	Total (6)	Pattern (7)	Level (8)
	(Per cent)							
Age group (years):								
15-19	35.6	3.1	−4.1	−4.8	0.7	36.6	−2.5	39.1
20-24	39.0	7.4	−6.8	−9.8	3.0	38.4	−0.7	39.1
25-44	36.1	6.4	−8.2	−10.9	2.7	37.9	−1.2	39.1
45-54	12.7	−15.3	−9.1	−10.6	1.5	37.2	−1.9	39.1
55-64	15.7	−11.9	−9.2	−10.6	1.4	36.8	−2.3	39.1
65 and over	11.4	−17.4	−6.7	−9.7	3.0	35.5	−3.6	39.1
Total, all age groups	29.7	-	−7.9	−10.1	2.2	37.6	−1.5	39.1

1 At the level of the total economy, the value of the age-mix factor is zero. This does not imply that the number of persons joining the labour force was equal to the number leaving. Rather, the zero arises from the fact that at the total economy level, the age mix (or pattern of ages in employment) equals 1.0 in 1971 and 1.0 in 1981; the difference, therefore, is equal to zero.

SOURCE Based on data from Statistics Canada.

data indicate that as age increases, the negative impact of technological change increases slightly, ranging from −4.1 per cent for the 15-19 age group to −9.2 per cent for the 55-64 age group.

The effects of change in the pattern of final demand are generally in the same range for all age groups, with the 20-24 age group losing the least (0.7 per cent). They are less likely to be found in industries with lagging demand. Finally, the impact of change in the level of final demand is uniform for all age groups. This is so since, when we assume that all patterns and proportions in the economy remain unchanged, a percentage increase in the aggregate level of activity is translated into the same percentage increase in employment in all sectors.

In conclusion, differences in employment growth by age groups are due primarily to change in the age mix of the labour force. But we have also observed a small increase in the negative impact of technological change as age increases. This reflects the industrial distribution of different age groups: between 1971 and 1981, young workers were found in industries that were less affected by technological change, while the reverse was true for older workers. The differences were not large, however.

Occupational Employment Patterns of Special Groups

While industrial distributions may not suggest a large differential impact of technological change on special group members, this does not rule out the possibility that occupational distributions will. Table 10-4 shows the shares in 1981 of seven age groups, of Native people, and of the disabled in the labour force (1983-84 in the case of the latter) and their occupational shares. Comparison of the share of a group in any given occupation with its share of the labour force indicates whether the group is over- or under-represented in that occupation. The very young (15 to 19 years) are relatively over-represented in sales, service, agriculture, and material handling occupations. Workers aged 20 to 24 are proportionately more concentrated in clerical, forestry, mining, and material handling occupations. And older workers (45 to 64 years) are relatively more concentrated in managerial, religious, and agricultural occupations. The fishing and the forestry occupations employ relatively more Natives.

It is important to note, as well, those occupations in which special groups are under-represented. In particular, youths, older workers, Natives, and the disabled are all relatively less visible in professional categories – natural sciences, teaching, and medicine and health.

Table 10-4

Share of Age Groups, Native People and the Disabled in Occupational Groups, Canada, 1981

	Age group (years)[1]							Native people	Disabled
	15-19	20-24	25-34	35-44	45-54	55-64	65 +		
	(Per cent)								
Managerial	0.9	6.3	30.6	27.3	20.6	12.3	2.1	0.6	5.0
Natural sciences, engineering, mathematics	2.1	17.2	39.6	20.9	12.0	7.2	0.9	0.4	3.1
Social sciences	3.4	13.3	39.8	20.7	12.4	8.2	2.2	2.1	4.4
Religion	0.4	2.8	15.2	17.9	22.9	23.6	17.3	0.3	--
Teaching	0.9	6.8	37.4	31.4	15.4	6.6	1.4	0.8	4.5
Medicine and health	2.4	15.7	36.3	22.0	13.8	8.1	1.6	0.5	4.9
Artistic and recreational	8.7	18.5	35.7	17.2	10.6	6.7	2.6	1.0	6.0
Clerical	9.8	22.4	28.8	17.0	12.6	8.0	1.4	0.7	5.5
Sales	13.2	14.4	24.1	18.5	16.0	10.8	3.0	0.5	5.6
Service	18.0	16.6	20.8	16.1	14.8	11.3	2.5	1.4	7.5
Agriculture	12.7	12.4	18.4	15.9	17.2	15.1	8.3	0.8	11.0
Fishing	7.8	15.5	27.8	20.6	15.5	10.7	2.2	5.7	--
Forestry	9.1	20.3	29.9	17.9	14.1	7.7	0.9	6.0	--
Mining	6.7	22.4	30.2	18.2	14.3	7.6	0.5	2.2	--
Processing	8.9	19.9	26.9	17.8	15.3	10.3	0.9	1.3	6.5
Machining	5.9	18.0	29.2	20.5	15.4	10.2	0.9	0.9	7.0
Product fabricating	6.5	17.1	28.3	20.6	16.4	9.8	1.3	0.8	6.4
Construction	6.0	16.5	28.3	19.9	17.7	10.5	1.1	1.9	5.3
Transport equipment operator	4.6	14.3	29.8	21.7	17.9	10.5	1.1	1.1	6.2
Materials handling	15.4	20.9	23.7	15.8	14.4	9.1	0.7	1.5	7.0
Other crafts and equipment operator	5.9	16.4	29.0	18.9	17.0	11.3	1.6	0.7	7.1
All occupations	8.6	16.2	28.2	19.7	15.4	9.9	2.0	1.0	6.1

1 The sum over all age groups constitutes 100 per cent of the occupational category.
SOURCE Based on data from Statistics Canada.

These occupational groups are at a very aggregate level. As they stand, they mask some very critical information. We may know, for example, that 20-24-year-olds are in clerical jobs, but are they in positions whose prospects are promising or threatening? Historical developments and future prospects for individual occupations are often quite diverse, and yet when they are combined into an overall group such as clerical, the differences are masked. What is more useful from an analytical point of view is to take a fine level of occupational detail. We can then examine certain aspects of the employment prospects according to a variety of indicators: how fast are these occupations growing, and are they at risk from the new technologies, for example?

First, growth rates were calculated for the 1971-81 period. The occupations were ranked to determine which were the fastest-growing and which the fastest-declining. The age groups were then tested for their representation in each of these categories. Table 10-5 illustrates quite clearly that the very young (15 to 19 years) and older workers (45 to 64 years) were not well represented in the fast-growth occupations. The evidence on their share of the fast-declining occupations relative to their share of the total labour force is not conclusive.

Table 10-6 selects 12 high-tech occupations and checks them for their age structure. It is partly the 20-24-year-olds, but substantially the 25-34-year-olds, who hold the high-tech occupations. Obviously, the training and education required for most of these jobs preclude the participation of 15-19-year-olds. Similarly, with older workers, their training and experience have been invested in older technologies, and it is only in the case of engineers and architects that they exceed their share of the labour force in the high-tech occupations.

Table 10-7 groups occupations according to the likelihood of their being threatened by certain computer-based technologies. For example, advances in robotics are likely to moderate the future growth of welders,

Table 10-5

Distribution of Employment in the Fastest-Growing and Fastest-Declining Occupations, by Age Group, Canada, 1981[1]

	Age group (years)						
	15-19	20-24	25-44	45-54	55-64	65+	Total
	(Per cent)						
15 fastest-growing	2.9	16.9	59.2	12.8	6.9	1.2	100.0
30 fastest-growing	4.8	21.1	54.5	11.7	6.8	1.1	100.0
15 fastest-declining	6.8	15.8	48.9	16.3	10.8	1.4	100.0
30 fastest-declining	14.4	19.0	43.1	13.7	8.3	1.5	100.0
All occupations	8.6	16.2	47.9	15.4	9.9	2.0	100.0

1 The growth rates that determined the fastest-growing and fastest-declining occupations were calculated over the period 1971-81.
SOURCE Based on data from Statistics Canada, Census of Canada, 1981.

Table 10-6

Distribution of Employment in Selected High-Tech Occupations[1] by Age Group, Canada, 1981

	Age group (years)							
	15-19	20-24	25-34	35-44	45-54	55-64	65+	Total
	(Per cent)							
Occupation:								
Physical scientists	2.6	19.8	38.8	19.1	11.3	7.6	0.8	100.0
Life scientists	3.2	20.1	39.8	18.9	10.3	6.6	1.0	100.0
Engineers	--	7.1	38.3	25.5	16.6	11.1	1.4	100.0
Architects	--	4.1	40.0	27.0	16.9	9.8	2.2	100.0
Math specialists	2.9	14.6	41.5	20.6	12.3	7.3	0.7	100.0
Engineering technicians	2.8	26.7	33.8	19.2	11.4	5.7	0.4	100.0
Computer specialists	2.0	21.2	51.2	18.0	5.6	1.9	0.1	100.0
Technicians: Radiology	1.3	21.1	44.9	22.1	6.8	3.4	0.4	100.0
Technicians: Medical laboratory	1.6	21.2	45.1	19.4	8.3	4.1	0.3	100.0
EDP equipment operators	6.8	28.9	38.3	15.9	7.4	2.6	0.2	100.0
Repairers: Electronic equipment	3.1	19.9	39.2	20.0	12.2	5.2	0.4	100.0
Mechanics: Precision instruments	1.8	15.2	39.5	20.0	13.8	9.2	0.5	100.0
Total, selected high-tech occupations	2.4	18.4	40.4	20.5	11.2	6.4	0.7	100.0
Total, all occupations	8.6	16.2	28.2	19.7	15.4	9.9	2.0	100.0

1 Defined as occupations which require an in-depth knowledge of technologies or have a high technology content.
SOURCE Based on data from Statistics Canada, Census of Canada, 1981.

painters, longshore workers, packagers, and so on. Hence these specific occupations are combined under robotics. Using this procedure, older workers are not over-represented in any of those occupations potentially at risk from computer-based technologies. The 15-19-year-olds are strong in occupations challenged by robotics, ATMs and debit cards, and statistical inventory, storage, and process control. The 20-24 age group is strongly represented in technologically high-risk occupations.

Table 10-7

Distribution of Employment in Occupations Potentially at Risk from Selected Computer-Based Technologies, by Age Group, Canada, 1981

	Age group (years)							
	15-19	20-24	25-34	35-44	45-54	55-64	65+	Total
	(Per cent)							
Occupations affected by:								
Robotics[1]	11.2	20.6	27.3	18.2	14.1	8.1	0.5	100.0
ATMs, debit cards, teleshopping[2]	17.0	18.6	21.2	15.7	14.8	10.4	2.3	100.0
CAD/CAM, CNC machines[3]	5.0	19.8	31.3	19.5	13.9	9.6	0.9	100.0
Computer diagnostic equipment[4]	8.3	22.1	31.1	18.6	12.6	6.5	0.8	100.0
Statistical inventory, storage, and process control systems[5]	14.9	22.9	25.3	13.6	12.5	9.7	1.0	100.0
Automated office equipment[6]	7.0	22.4	28.7	17.9	13.9	8.8	1.4	100.0
Total, all occupations	8.6	16.2	28.2	19.7	15.4	9.9	2.0	100.0

1 Occupations affected by robotics include: welders; painters; assemblers of autos, of electrical equipment, and of electronic equipment; hoisting equipment operators; longshore workers; material handling equipment operators; packagers; and material handling labourers.
2 Occupations affected by ATMs, debit cards, and teleshopping include tellers and cashiers, and sales clerks.
3 CAD/CAM and CNC machines affect draughtspersons, tool and die makers, machinists, machine tool operators, and metal-working machine operators.
4 Computer diagnostic equipment affects motor vehicle mechanics and electronic equipment repairers.
5 Statistical inventory, storage, and process control systems affect production clerks, shipping/receiving clerks, and stock clerks.
6 Automated office equipment affects typists, bookkeepers, file clerks, mail clerks, and telephone operators.
SOURCE Based on data from Statistics Canada, Census of Canada, 1981.

Educational Attainment of Special Groups

Many observers feel that the ability of the work force to adapt to technological change depends critically on their educational preparation. A disturbing feature common to all special groups is their relatively low level of formal education (Table 10-8). Native peoples with less than Grade 9 represented about 41 per cent of the adult Native population not attending school full-time in 1981; the corresponding figure for the non-Native population was about 22 per cent. Of the disabled (aged 15 to 64), about 35 per cent had less than nine years of schooling in 1983-84, compared with 14 per cent for the nondisabled. Among older workers (aged 45 to 64), too, the proportion that never reached high school was large. It was 33 per cent for the 45-64 age group, while it was only 6 per cent for the 20-24 age group and 12 per cent for the 25-44 age group. Most of the very young (15 to 19 years) who were out of school (about 786,000 in 1981) had some secondary education, but the number who had not successfully graduated was high – 66 per cent. This represents a very large number of young people without a basic education. The drop-out rate is too high, as the Ontario Youth Commissioner pointed out in his 1986 report.[6] Excluding private schools, 40 per cent of students in Ontario who attend Grade 9 do not graduate from Grade 12, and 76 per cent do not graduate from Grade 13.

Bearing in mind the generally poorer education of special groups, it would be useful to look at jobs characterized by people with low education levels. These jobs span all industries and a wide range of occupations. In 1971, about 27 per cent of employees in the business sector had less than Grade 9; by 1981, however, this figure dropped to 14 per cent. Clearly, jobs characterized by individuals with less than Grade 9 have been diminishing.

In general, the Canadian population has been acquiring a better education. New entrants to the labour market have typically more years of schooling than older generations already in the labour market. With fewer people around having less than Grade 9 education, jobs characterized by employees in that category will naturally be on the decline. But over and above the change in the "education mix" of the population, have low-

Table 10-8

Distribution of Special Groups, by Highest Level of Schooling Completed, Canada, 1981[1]

	Elementary/secondary only				Postsecondary but no university	Some university	Total
	Less than Grade 9	Some secondary	Secondary graduate	Trades certificate			
	(Per cent)						
Age group (years):							
15-19	11.5	54.9	21.7	3.0	7.5	1.3	100.0
20-24	5.5	31.4	22.4	4.0	25.6	11.1	100.0
25-44	11.9	21.7	14.7	3.7	25.2	22.7	100.0
45-54	29.9	24.5	9.6	4.7	18.3	13.0	100.0
55-64	37.2	25.1	8.5	4.0	14.7	10.5	100.0
65 and over	50.7	21.8	6.4	2.6	10.9	7.6	100.0
Natives	41.4	29.9	6.1	2.4	(20.2)		100.0
Non-Natives	22.0	25.2	13.4	3.7	(35.7)		100.0
Disabled (aged 15 to 64)	35.5	(46.6)			(17.9)		100.0
Nondisabled (aged 15 to 64)	14.4	(52.6)			(33.0)		100.0

1 Data on age groups and Natives apply to the adult population not attending school full time in 1981. Data on the disabled apply to the population aged 15-64 years. A large proportion of the disabled are over 65 years of age, and since the education levels of that age group are typically very low, they were excluded. The disabled data relate to the period June 1983 - October 1984 and use Statistics Canada's *Labour Force Survey* definitions.

SOURCE Based on data from Statistics Canada.

Table 10-9

Sources of Employment Change in Three Educational Attainment Groups, Canada, 1971-81

	Change in employment, 1971-81	Change in employment as a result of change in:					
		Education mix	Occupational mix	Labour productivity	Intermediate demand	Pattern of final demand	Level of final demand
	(Per cent)						
Less than Grade 9	−33.3	−52.6	−3.3	−10.3	−1.8	−4.4	39.1
Grade 9 or more but no university	41.9	11.8	−0.3	−9.5	2.1	−1.3	39.1
Some university	66.9	22.7	6.6	−12.3	9.1	1.7	39.1
Total	29.7	0.0	0.0	−10.1	2.2	−1.5	39.1

SOURCE Based on data from Statistics Canada.

education jobs been diminishing as a result of other forces? Have industries, for example, been shifting their staffing patterns such that their demand for occupations typified by higher education is greater than their demand for occupations typified by lower education? Has productivity growth been slower or faster for jobs employing persons with less than Grade 9, and has this been translated into less or more worker displacement? Have patterns of consumer and government demand shifted such that the demand for products of industries employing persons with less than Grade 9 has been stimulated, or has it lagged?

By this point in the report, these questions will have become quite familiar. We shall again call upon the procedure of Chapter 3 to gain insight into them. And, in

particular, we shall retain the definition of technological change and let it include changes that are the result of change in the occupational mix, change in labour productivity, and change in demand for intermediate inputs. We can then judge whether jobs characterized by persons with less than Grade 9 have been more or less affected by technological change than other jobs, and in what direction.

The results are shown in Table 10-9. Employment has been classified according to three educational attainment levels – persons with less than Grade 9, persons with Grade 9 or more but no university, and persons with some university. Change in employment in each of these groups can be attributed to six sources. Five of the sources are the same as in Chapter 3. The one new source is the "education mix." It reflects the impact of changes in the supply of workers with different educational attainment levels.

Employment of the very poorly educated in the business sector has declined by one-third. Most of this decline has been due to the general increase in education levels in the supply of workers; nonetheless, the other factors have had an important role to play. The general increase in the level of demand has counteracted the negative effect of the education mix, while the other four sources of change have reinforced it.

Shifts in industry staffing patterns have been toward occupations held by persons with some university. The relative impact of this factor is far more important for occupations with some university education (an increase of 7 per cent) than for occupations with less than Grade 9 (a loss of 3 per cent). Increased productivity has reduced employment in all groups, but the university-educated were affected the most (a loss of 12 per cent).

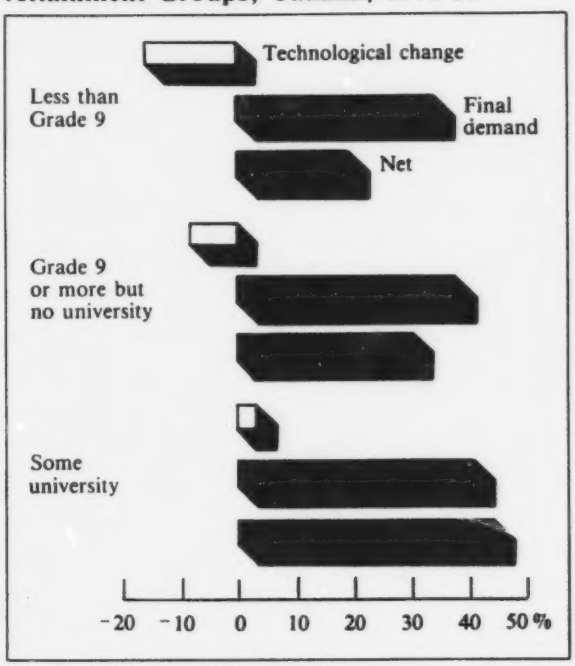
The effect of technological change was to reduce employment of persons with less than Grade 9 by 15.4 per cent and persons with Grade 9 or more but no university by 7.7 per cent. On the other hand, technological change acted to increase employment of persons with some university by 3.4 per cent. These results are summarized in Chart 10-1. Clearly, it is persons who have not reached Grade 9 who have experienced the greatest negative repercussions from technological change.

Expanding Opportunities for the Disabled

Of all the groups in society, the one that has the greatest potential for gain from technological change is perhaps the disabled. The last 15 years have seen remarkable developments in technical devices, and these devices are already helping thousands to overcome the problems of daily living. For the severely physically disabled, the electric wheelchair can be controlled by anything from a slight head movement to use of the tongue to touch an ultra-sensitive pad. In addition, such a person can use remote control systems to turn on lights, tune a radio, or switch television channels. For the visually impaired, electronic print magnification uses closed-circuit television to enlarge print far beyond the capacity of mechanical optics and for the blind, paperless braille devices that use audio cassette tape as the storage medium for brailled information and a plate of movable pins to present the taped data back to the user in the original brailled format. For the speech-impaired, there is a vast array of aids that enable them to communicate – ranging from devices that allow a simple "yes" or "no" response to a synthetic voice machine controlled by the use of a standard keyboard or a scanning device that selects words or letters. Examples abound of such devices and of individuals being

Chart 10-1

Change in Employment as a Result of Changes in Technology and Final Demand in Three Educational Attainment Groups, Canada, 1971-81



SOURCE Based on data from Statistics Canada.

better able to move, see, communicate, and hear because of them.

Of almost equal importance is the impact that these and related devices will have on employment opportunities. Attitudes are changing; the disabled are increasingly moving out of institutions, and there is a growing desire on the part of many to live independent, productive lives. Technical aids have the potential to bring the disabled more actively into the work force and to permit them to realize many of their aspirations.

Technological change in the economy in general may have certain negative effects on the job prospects of the disabled. To the extent that the disabled are concentrated in particular technologically affected occupations, jobs may be lost. In the case of the visually impaired, for example, darkroom film processing, court recording, and dicta-transcription readily lent themselves to these individuals in the past, but the advent of automated processing has already eliminated or shrunk demand for those occupations. As with poorly educated youths and Native peoples, the disabled often hold low-skill, low-education and low-paying jobs. To the extent that technological change threatens these jobs, the disabled will be disproportionately affected.

But just as technological change may be closing some doors to the disabled, many others are being opened. They are being opened by the special devices that have been developed and, in particular, by the fact that adaptive devices make computers accessible to many. With access to computers, countless jobs involving information collection, processing, storage, and retrieval, throughout all segments of industry, become potential placements for the disabled. A blind individual with a microcomputer and a speech synthesizer can enter, process, and store words and data on the computer and subsequently retrieve and "read" the information almost as easily and quickly as a sighted person. An individual with limited mobility has several options that enable the standard keyboard to be bypassed. They range from a mini-keyboard with small, closely spaced keys that can be activated by a narrow probe attached to a mouth stick or a head pointer to a king-sized keyboard with letters slightly recessed, to technology involving an oral "puff-and-sip" switch combined with Morse code.

New occupations are being opened as well by certain features of the new information technology that offer special advantages to the disabled. Each of the operations of information collection, processing, storage, and retrieval can be performed at a single work station. The physical movements needed to perform such tasks are minimized. Consequently, an individual in a wheelchair or using another mobility aid can more easily be integrated into an office environment without the necessity of a major redesign.

Information technology integrates physically separate machines such as word processors, main frames, microcomputers, and various telephone aids. Instantaneous access to the network over space can lead to decentralization in production or office work. Employees can perform a range of tasks from remote locations, thus removing the need to travel. This is particularly desirable for those disabled who find transportation a major barrier to employment. Work can be done at home or in sheltered workshops, or, as is the case with certain employees in the federal Department of Transport, in both the office and the home. They work in the office for a time, but when pressure sores develop they shift operations to their residence. The problem of absenteeism is overcome.

The introduction of information technology is not unique or deterministic. There is considerable flexibility on the part of management in terms of its impact on work skills and organization, and consequently there is considerable leeway for adjusting jobs to suit the needs of disabled employees. Job redesign could involve more specialization, for example. Job content could be restricted to a specific activity, with the employee becoming a specialist in that activity. Limiting secretarial duties to include only word processing would create a word-processing specialist. An individual with very limited physical abilities might not be able to execute all the tasks of a secretary but might be suited to the more specific tasks of a word processor. By contrast, job redesign could involve job enlargement. Take the case of a disabled person who is at a work station, but the work is intermittent. Information technology allows the assignment of additional duties unrelated to the main job but at the same work station.

It is still early to report large numbers of jobs going to the disabled as a result of adaptative devices, access to computers, and the nature of information technology. But progress has been made, and there are many disabled persons holding jobs that heretofore would have been impossible.

Within the federal government, about 2,500 disabled have been placed since 1981. Actions taken in response to the recommendations of the Special Parliamentary Committee on the Disabled and the Handicapped have been partly responsible for the government's more active role in hiring the disabled. In particular, these actions have included the establishment of the Program of Services to Handicapped People and the expansion of affirmative-action employment programs for disabled persons in federal departments and agencies. Many of these placements were made possible by technological change and adaptive devices. In cases where handicapped employees or successful job applicants required aids but had no other recourse to them, departments

provided them. A small bank of basic aids and devices is maintained by Supply and Services Canada, and the Public Service Commission supplies information on aids and resource manuals.

Awareness of technical aids and the enhanced capabilities of disabled persons is gradually spreading in the public sector. Smaller inroads have been made in the private sector. Some employers do not realize the possibilities of new technologies and even in an interview with a disabled person, they are reluctant to ask how the candidate would handle certain work situations for fear of embarrassment. The question unasked goes unanswered, and although the problem might have been explained away, the job goes to a nondisabled person.

A major concern of prospective employers is the cost. To equip a disabled person for a job need not necessitate huge expenditures. Many devices, especially the complex ones, are expensive; but just as many are not. Provincial governments, and non-profit organizations and agencies, often subsidize the costs of aids. Employment and Immigration Canada, in its Canadian Job Strategy, will provide $10,000 for the installation of special facilities if a job is created for a disabled worker. Nor does it need to be expensive to equip a job site to accommodate employment of the disabled. Often there are very simple and inexpensive solutions to seemingly difficult problems. For example, consider the case of an insurance company that hired an individual confined to a wheelchair. The company had plans to install costly automatic doors to enable the person to enter a security area. They received a suggestion to place a switch outside the door that would operate a light that was visible to the guard inside, who would then open the door. Considerable savings were realized.

Given that many of the problems encountered by the disabled in the workplace have been solved before, and given the general lack of awareness of the impact of technical aids on the employability of the disabled, it would be useful to have some central source of expertise to provide such information. It would supply information on technical aids, sources of supply, and associated prices. It would provide ideas on architectural modification and job redesign, and it would provide names of contacts who had encountered similar difficulties and dealt with them successfully. The United States has such an arrangement, called the Job Accommodation Network (JAN). It has a toll-free number that companies can phone for computerized information.

In Canada, similar but less comprehensive efforts have been undertaken. The CNIB, for example, has compiled a "Survey of Occupations" held by the blind and visually impaired.[7] On the basis of interviews, it describes 220 occupations in detail and lists a further 300 in less detail. It is due to be put in electronic form, to be accessed through a microcomputer bulletin-board system. This would be useful input to a central source of information.

The Disability Information Services of Canada is an information network operating out of the University of Calgary, under the direction of the Secretary of State. It provides information to the disabled on their daily needs, including employment-related issues. If its mandate were expanded, it would provide an excellent vehicle for a "JAN-type" information service.

Another useful means to communicate the potential of technical aids would be to arrange displays of the equipment. A pilot exhibit was arranged in Ottawa by Supply and Services Canada, for example.[8] Its purpose was to increase awareness and appreciation of technical aids among disabled employees and their managers in the federal and provincial governments. The exhibition also gave suppliers an opportunity to increase the visibility of their products, and accompanying seminars illustrated concrete examples of their implementation. Employers in the private sector and in other urban centres would benefit from similar shows.

Conclusion

The characteristics of young workers, older workers, Native persons, and the disabled, together with the nature of Canadian labour markets, have historically rendered members of these groups more at risk to labour-market problems than the general population. These groups have their own industrial and occupational concentrations, and given the considerable variation in the impact of technological change on industries and on occupations, this chapter has asked whether technological change has consequently had greater repercussions for some groups than for others. It was found that differences in industrial distributions among age groups did not imply a large differential impact of technological change on age groups. With respect to differences in occupational distributions, the young, the old, and Natives do not appear to be heavily overrepresented in the most rapidly declining occupations. Nor, however, are they found in occupations with the highest anticipated growth rates.

The educational attainment levels of all special groups is relatively low. When jobs held by the most poorly educated were tested for the impact of technological change, they were found to be more negatively affected than jobs characterized by persons with more education. The implication of these results is that to minimize problems in the labour market, Canadians must be encouraged to attain at least a basic minimum level of formal

education. That education can be quite general in nature or quite focused and specific. Both types will improve an individual's employment prospects, but in these times of change, there might be something particularly beneficial in a broadly based education. Careers of the future will be not in one field but in several, and a broader education will allow greater flexibility and enable adaptation to change.

Of all the special groups, technological change offers the greatest opportunity to the disabled. Special aids, access to computers, and the nature of the new information technology all promise to open new occupations. There is optimism on the part of counsellors and agencies. As various representatives have told us, "sight, hearing, mobility or their absence will become less of a consideration in hiring or promotional situations"; and "the ability/disability border is being eroded." The opportunity can only be realized, however, if employers are aware of the possibilities. It is important to publicize technical aids and explain how they may be integrated into the work environment.

11 A Strategy for a High-Tech World

Our principal conclusion is that, *together*, the rapid adoption of the new technologies and the development of human resources can bring economic progress and more and better jobs. At the moment, however, Canadians must face up to some uncomfortable facts:

- Canada's industry continues to lag behind that of other countries in adopting the new technologies that are essential to its future prosperity. Thus Canadians have a lot of catching up to do.

- Technological change is never smooth and balanced; it creates both winners and losers, and Canada must do a better job of helping the losers to cope.

- The pace of change in the global economy will remain rapid, and it may even accelerate; so the next round of innovation will have more profound employment consequences than previously.

Objectives and Goals

In our view, Canada lacks the explicit national commitment to new technologies and the cohesive framework of policies that must accompany such commitment. We will therefore set out in this section a framework that points the way towards jobs and well-being for all in a technologically advanced society. This framework rests on "twin pillars." The *first* is rapid adoption of the new technologies. In our view, Canadians have no choice: it is a matter of survival. If Canada does not use the new technologies, its trading rivals will; and jobs will be lost as a result. The *second* facet of this new orientation is a cohesive program of labour market adjustment to develop a well-trained labour force that can fully, rapidly, and fairly exploit the potential benefits of technological change.

These "twin pillars" are clearly mutually supportive: programs that prepare people for the challenges of change and that lessen the pain of transition will enhance the acceptability of the new technologies and hasten their adoption. In short, an innovative economy and adjustment support go hand in hand: one cannot exist without the other.

To give substance to this framework, we advance five related policy objectives:

1 In order to increase productivity, competitiveness, incomes, and employment, all Canadians must openly embrace the new technologies. There is no alternative: failure to do so would entail a loss of prosperity and jobs.

2 The new technologies are vitally necessary, but, alone, they are not sufficient to generate the improvements we seek. A well-trained, flexible, and committed work force is equally important.

3 Technological change is uneven and disruptive. An adjustment policy is required to ensure that its costs are minimized and its benefits are shared.

4 For technological change to be successful, Canadians must innovate on two fronts. Success depends as much on innovations in organization and the development of human resources as it does on technical expertise.

5 If Canadians are to enjoy the fruits of technological progress in a fiercely competitive world, a more constructive industrial-relations climate is essential.

These objectives flow from the "twin pillars"; they are, in turn, the means to achieve the ultimate goal of increased productivity, competitiveness, incomes, and jobs. Together, these elements make up our strategic policy framework. In constructing it, we were guided by the following principles:

- We expect that, in general, decisions with respect to the choice of technologies, of training arrangements, and of adjustment mechanisms will come from the market, with employees and employers identifying their own needs and working out their own solutions.

- At the same time, however, governments will have a very important role to play in establishing the climate within which change must take place.

- Governments should continue to finance training and other adjustment policies; for the most part, however, we advocate a reallocation of expenditures rather than large amounts of new funding. The focus must shift towards a more positive adjustment strategy.

- Adjustment programs must be flexible enough to meet the varying needs of individuals, whether their dis-

placement stems from technological change or from other causes.

- Finally, all segments of Canadian society share a strong interest in the prosperity and jobs that technological change can bring; this commonality of interest should be recognized and enhanced.

In the following pages, we consider specific measures to support each of the five policy objectives in turn.

Rapid Technological Advance

Objective 1:

In order to increase productivity, competitiveness, incomes, and employment, Canada must openly embrace the new technologies. There is no alternative: failure to do so would entail a loss of prosperity and jobs.

What is needed is nothing less than a major shift in attitudes and an upgrading of the status given to issues of technological change. Our research clearly shows that technological change brings with it the opportunity for growth in productivity, incomes, and employment. Canada's economy is very open to international trade, but this country is lagging seriously in the introduction of new technologies. Unless Canada closes the gap, the fruits of technological change will be enjoyed outside its borders. This means that while industrial adjustment will still take place in Canada, it will be in response to failure, not to success. A national commitment to technological change is therefore vital.

The appropriateness of a science and technology policy for Canada has been the subject of national debate for some time now. And in fact, more progress has been made in the 1980s than in all of the three preceding decades. Positive signs include the formation of the National Advisory Board on Science and Technology, chaired by the Prime Minister; of the House of Commons Standing Committee on Research, Science, and Technology; and of the Council of Science and Technology Ministers, a joint federal-provincial body. The mere existence of these bodies is not enough, however; it is the follow-through that is all-important.

Another positive sign is the progress being made in the private sector towards the achievement of a consensus on the important elements of a science and technology policy. This includes, for example, policy statements made by the Canadian Advanced Technology Association and the Canadian Manufacturers' Association. An important principle underlying these statements is the acknowledgment that R&D alone, though necessary, is not enough; other key elements include the rapid adoption and diffusion of technological change throughout Canada and throughout Canadian industry, as well as attention to the labour market repercussions of, and adjustment to, technological change.

Raise the Profile of Science and Technology

The potential momentum offered by such steps must be reinforced now by governments, at both the federal and provincial levels. First and foremost, the federal government must play a leadership role by raising the status of science and technology both in Parliament and in the cabinet, and in policy decisions throughout the federal public service. This means that the status of the Minister of State for Science and Technology must be raised to that of senior cabinet minister. Provincial governments also have an important leadership role to play. They, too, can raise the profile of science and technology issues within their own jurisdictions.

Knowledge of, and pride in, Canadian achievements are an important part of a commitment to technological change, and it is here that the media play a key role in national consciousness-raising. Science features, news of Canadian successes, and details of private- and public-sector activities in science and technology can all contribute towards the goal of raising the profile of technology issues.

Improve Technology Information

There is also room for improvement with regard to some existing activities. To provide the information on, and assistance in, the implementation of technological change that is often required, governments – federal and provincial – have established a number of high-tech and innovation centres in recent years. The result, however, is that currently businesses are faced with a bewildering array of centres focusing on a variety of technologies. Some of these centres are federal, and many are provincial; some are university-based, and others are independent organizations. And still others have been created by industry. The sheer number and variety of high-tech centres discourages some potential clients from even attempting to find which one is most appropriate for their needs.

Furthermore, while some of these centres, known as "incubation" or "innovation" centres, provide a full range of services from market research and technological assessment to assistance in the formation of a business, others focus only on the narrower, more technical aspects of innovation. Often, guidance on the "softer" side of technological change – including human

resource planning – is lacking. We see two ways, therefore, in which the present system of high-tech centres can be improved.

First, a mechanism for coordinating access to the network of technology and innovation centres needs to be put into place. This mechanism would, in a sense, act as a directory, aiding businesses and those wishing to start a business in identifying which centre or combination of centres is most appropriate for the needs at hand. Here, as with other initiatives proposed in this Statement, we are not suggesting that new funds be made available but rather that existing budgetary allocations be used more effectively.

Second, the expertise of all centres should be rounded out to include not just the purely technical aspects of technological change, but the human resource planning and management aspects as well. The recognition that successful technological change consists of a package made up of technical and human resource planning and management is an important lesson that we have distilled from our research.

Enrich the Technology Debate

Finally, in order to use technological change most effectively for continued growth in living standards, there is a need to be informed on an ongoing basis about the rate and direction of change and about the nature of its impact. Research centres with this function exist in a number of European countries, but, to date, there has been no overall focus for issues of this nature in Canada. Concern for fiscal restraint probably means that the establishment of a new centre devoted to research on the social and labour market impacts of technological change, on labour market adjustment, and on organizational design is not feasible at this time. But much more could be done within the existing institutional arrangements.

The importance of technological change for Canada's economic future is apparent. It is highly desirable, for example, that the major economic partners in this country reach a mutual understanding about the need for rapid technological advance and the fair and efficient handling of its benefits and its costs. Much of this must be achieved with patience and good sense in the workplace. But much could be done at higher levels of representation to raise the awareness and understanding of technological change issues and to codify "best practice" in this area. We are persuaded by the examples of collaboration in sectoral task forces, the Major Projects Task Force, and the Canadian Steel Trade Conference, which show that employer and labour representatives can work impressively together on major issues of mutual concern. Many observers had hoped that the Canadian Labour Market and Productivity Centre would be a showcase of such collaboration. We believe its exciting potential might yet be realized if it were focused on a single, urgent, and vital national issue, such as technological change.

Through research and the dissemination of information, and particularly through workshops, conferences, public forums, and demonstration projects, employers and labour representatives could do much to inform their constituencies – and each other – of relevant Canadian and foreign experience, of the lessons to be learned, and of the essential ingredients of "best practice."

A Flexible and Well-Trained Work Force

Objective 2:

The new technologies are vitally necessary but, alone, they are not sufficient to generate the improvements we seek. A well-trained, flexible, and committed work force is equally important.

A skilled and adaptable labour force is essential on two counts. First, it is a necessary condition for achieving the gains in productivity and competitiveness that potentially reside in advanced technologies. Second, people with the tools to adapt to the new environment will find it easier to make the necessary adjustments. Hence, rapid adoption of new technologies, and successful adjustment to them, depend heavily on the quality of Canada's labour force. That, in turn, depends on the quality of the education system in general and of skills training.

Learning to Learn

Education is a cornerstone. Its importance in a high-technology world cannot be ignored because the accelerating pace of change will lead to rapid obsolescence of skills. The education system therefore faces a profound challenge. It must prepare individuals to be mobile, flexible, adaptable, and versatile.

The ability to learn will be the premium skill of the future. The traditional sequence of formal schooling, on-the-job training, and lifetime practice of one's trade or profession is already being superseded by a more cyclical pattern in which periods of reschooling and retraining feature prominently.

Deficiencies in basic literacy that must be corrected before such "retooling" can occur are an urgent problem for many individuals. So are the appalling inade-

quacies in educational attainment for special groups in Canadian society – inadequacies that severely hinder the ability of these groups to cope with technological change, as our research shows.

Technological change compounds the urgency of this literacy problem. People with low levels of education have always had poor wages and a high incidence of unemployment. Now, their situation is worsening, at least partly because of technological innovation. The impact of technological change on employment is strongly related to educational attainment. In comparison with other groups, Canadians with less than Grade 9 education – often considered the literacy boundary – have experienced serious job losses as a result of the introduction of new technologies. Yet, Canada still has shockingly high rates of high school dropouts.

A two-pronged attack is necessary. First, school retention rates and average educational attainment levels must be raised if the employment and income prospects of future generations of workers are to be improved. Second, for many adult workers, imaginative remedial-education programs and vocational training are required.

More Skills Investment in Industry

In the computer age, the economic performance of firms depends, more than ever, on a well-trained work force. Canadian companies must recognize that training is not a cost but an investment. While many establishments in this country do carry out some retraining when introducing technological change, much of this activity is unstructured and of short duration. It is quite possible that Canadian employers, as a whole, are underestimating the skills required by the new technologies and are underinvesting in training as a result.

For many years, the federal government has offered some support for company training through wage subsidies and the reimbursement of instructional costs. The national industrial training programs do not, however, appear to be making a significant contribution towards encouraging the employer-sponsored training that we believe the new technologies demand. In fact, only one in eight technology-related training programs reported by the survey respondents received any financial assistance from government.

Yet if Canada is to have the human resources that can make the new technologies work, public policy must encourage appropriate levels and types of vocational development within industry. Government support for industrial training must be more accurately focused. Several studies have concluded that, in the past, much of the publicly funded training effort has been directed at occupations with a surplus of workers; for the most part, these are not the occupations that require training for technological change. Only when programs are explicitly directed at specific high-level skills that are clearly in demand do they respond to the direct needs of employers in the area of technology-induced training. In upcoming years, technological change will increase pressures for selected highly skilled occupations; in our view, support for employer-based training in these areas should be an explicit priority for the federal government's training strategy.

Facilitate Continuous Learning

A major thrust of public policy should be directed towards individuals. We have emphasized that technological advance leads to the obsolescence of skills and thus renders "one-career" work lives increasingly uncommon. More and more Canadians must be willing to retrain and reschool at various times: "continuous learning" has become more than a buzzword. Not only is technological change heightening the imperative for skills development by eliminating old jobs and creating new ones, but it is also reducing the employment available for those without advanced skill levels. Canadians need to have an institutional framework that will give them the opportunity to get the retraining and reschooling that they require in order to make the inevitable employment transitions throughout their working lives.

In our opinion, the direction for public policy in the training field should be to provide an "enabling" context – i.e., an environment within which employers and workers can make informed decisions about necessary retooling and can then carry out the required training. The Council does not recommend significant increases in public training expenditures; however, we believe that some reallocation of existing training funds could pay big dividends in the future. The central principles in a retraining policy framework should be:

- private initiative in making training choices;
- support for joint employer-employee solutions;
- concern for those disadvantaged in the labour force;
- flexibility in program design and administration; and
- decentralized decision-making.

In such a framework, the role of governments should be twofold: first, to provide funding arrangements aimed at facilitating the achievement of the goals; and, second, to ensure the availability of accurate information on the labour market.

There are some interesting recent initiatives in various provincial jurisdictions that recognize some of these

principles. Important developments have occurred at the federal level as well. A primary focus of the Canadian Jobs Strategy, introduced in 1985, is on those who have an employment disadvantage. In addition, the CJS administrative framework appears to emphasize flexibility, at least to the extent possible within such a massive program. In principle, the initiatives that receive funding are to be determined, not in Ottawa, but at the regional (and even local) level.

Providing Funds and Leave for Training

One of the six Canadian Jobs Strategy components that has attracted our attention is the Skill Investment program. Compared with the other elements of the CJS package, this component has a relatively low profile and budget. It focuses on retraining workers in positions threatened by change and includes options that, in our view, support the kinds of skills development arrangements that are called for in a high-technology labour market.

One such option is the training trust fund, in which the federal government will match employee and employer contributions to build a fund for future training. Disbursements from the fund are authorized by a labour-management board of trustees. Another Skill Investment option is the extended training leave. Here, the employer and a worker whose job is threatened agree to full-time leave so that the employee may pursue vocational development, with the federal government and the employer both contributing to his/her salary.

These approaches facilitate continuous learning through innovative arrangements. To this point, however, neither the trust-fund option nor the extended-training-leave option has had a high "take-up" rate, although there are some good examples of training funds operating in the construction industry.* We are concerned that this reflects inadequate commitment on the part of Canadian industry to invest in the skills of its workers. We believe that programs along the lines of the trust-fund and extended-leave options hold considerable promise for strengthening Canada's industrial training effort. Accordingly, the federal government should seriously consider ways of tailoring these kinds of approaches in order to increase their attractiveness to the private sector.

The Council has supported the concept of vocational leave before. In our last major report on the labour market, *In Short Supply*, we recommended that Canada ratify, and consider the means of implementing, the convention adopted by the International Labour Organization in 1974, which recommends that every member country formulate and apply a policy for the promotion of paid educational leave. This has not yet occurred in this country, although the importance of lifelong vocational development continues to grow. We would therefore like to focus attention once again on the feasibility of implementing a paid-educational-leave policy in Canada. Naturally, the administration of such a policy – and, especially, the question of who will pay for it – is a contentious issue. We suggest a shared responsibility among workers, employers, and governments. All will benefit from a society where reschooling and retraining are accessible.

While supporting the widespread application of skills-development-leave arrangements, we are not unfamiliar with their limitations. In particular, they are generally useful only to employed, and often long-employed, individuals. Yet it is people without jobs who, above all, need these opportunities. There has been some recent discussion – by the Skill Development Leave Task Force, for example – of voucher schemes to support retraining or reschooling. We believe these could play an effective role in helping Canadians adjust to technological and other changes.

There are precedents for voucher-style programs in this country. Most recently, in the early 1980s, portable wage subsidies were offered under the Industrial and Labour Adjustment Program for laid-off older workers in designated industries and communities. This subsidy took the form of a voucher given to the individual, who could offer it to a prospective employer. Our proposal is to use similar vouchers to cover the costs of legitimate employer-sponsored training. They could also be used as tuition for programs at education or training institutions. In addition to enabling the older workers to pursue continuous learning, this approach would encourage institutions to respond to market demands. Much of the funding for a voucher plan could be taken from existing training programs. The major departure of this approach is not in the expenditure levels that would be required but, rather, in the source of the initiative for training.

The underlying idea is that workers could spend their vouchers in ways that they determined as most appropriate for developing the desired vocational skills. In countries where such systems exist, the worth of the vouchers tends to be based on the worker's age or on the length of his/her attachment to the labour force. While this increases their usefulness as an adjustment tool for older workers, it does not do so for young people and, in many cases, women. Entitlement details would therefore require considerable attention.

*Funds in the construction industry tend to be operated jointly by unions and employers' associations. Two Ontario examples are the International Union of Operating Engineers Local 793 Training Fund and the Labourers' International Union Local 183 Training and Rehabilitation Fund.

Improve Forecasting

Accurate and timely information is essential if suggestions along these lines are to be of maximum use. The need for *prospective* information is particularly critical because many costly education and training decisions must be taken months and years in advance. We wish to emphasize that the importance information is further magnified by technological change and, in particular, by its rapidity.

In this light, we must draw attention to the need for greater emphasis on labour market forecasting in this country. The Canadian Occupational Projection System (COPS), which we used in Chapter 4 of our research report, is an ambitious attempt to involve a variety of users of labour market information and to draw on various sources of data to provide detailed occupational projections. Despite concerted efforts to augment the system by means of special studies and analytical refinements, however, it is still unable to incorporate systematically the effects of technological change. We therefore urge Employment and Immigration Canada to assign high priority to correcting this deficiency, drawing on the innovative work done with the Micro-Electronic Simulation Model (MESIM), also used in Chapter 4 of our research document.

Efficient and Equitable Adjustment Assistance

Objective 3:

Technological change is uneven and disruptive. An adjustment policy is required to ensure that its costs are minimized and its benefits are shared.

In a rapidly changing economy, it is essential that individuals be able to adjust to shifting circumstances. We have stressed that a flexible and appropriately skilled work force contributes to both efficiency and equity objectives. Indeed, the proposals put forward in the preceding section are designed to stimulate the formation of such a labour force by encouraging continuing skills development in those areas in demand. The intent of those proposals is to create an institutional framework in which individual adjustment to change becomes an ongoing process.

We emphasize individual adjustment because, realistically, some displacement will inevitably occur during the process of change. Studies of displaced workers show that, in human terms, the word "adjustment" may encompass such hardships as reductions in family income, deteriorating health, neighbourhood and community decline, loss of self-confidence, depression, marital strife, and drug and alcohol abuse. And the longer a spell of joblessness persists, the lower are the chances of successful re-employment. We firmly believe, therefore, that a variety of means must be explored at various levels if the pain of transition is to be minimized.

Easing the Transition

At the level of the individual firm, for instance, we are impressed by the examples of North American companies that have made genuine efforts to "close the door gently." In anticipation of closure and layoffs, some firms, in addition to severance pay, have offered assessment and testing, as well as remedial-education and retraining programs. Many have offered counselling on job availability, interviewing skills, and résumé writing, as well as advice on making the transition to a new employer. Some have set up local employment committees in conjunction with a union and with government placement agencies, while others have undertaken sizeable advertising campaigns to alert other area employers of the availability of various skills.

Unions, too, have an important role to play. We note the example of Local 1005 of the United Steelworkers in Hamilton, which has initiated a unique assessment and retraining program for laid-off members, using facilities in their refitted union hall as well as the services of Mohawk College.

Such initiatives are necessary and laudable. In many cases, however, there will be severe limits on how much individuals, firms, and unions can accomplish. A broader, public framework of adjustment assistance is therefore necessary.

The Industrial Adjustment Service

The federal government's labour market policy package includes the Industrial Adjustment Service, which bears particular relevance to this issue. The objective of the IAS is to encourage management and labour to work together towards an effective adjustment of the labour force to economic or technological change. The program typically operates at the establishment level through a bilateral committee, which oversees the development and implementation of solutions to the particular adjustment problems involved. Such problems might include layoffs, technological change, plant expansion, high turnover, or sagging productivity, to name just a few examples. In addition to facilitating the negotiation of an adjustment agreement and the establishment of the committee, the IAS plays a consultative role in the adjustment process, particularly with respect to the use of available labour market programs.

It also funds a portion of the committee's expenses. While the government is the facilitator, however, it is the parties themselves who must work out a solution.

The Industrial Adjustment Service has received good marks from various policy reviews and, indeed, has developed a favourable reputation outside this country. A number of American states have examined the program closely, with an eye to adopting it themselves. The IAS has had a positive impact on easing labour market adjustment problems and has fostered labour-management cooperation. It has proven to be a fast, flexible, and cost-effective method of promoting adjustment. There have been suggestions that the IAS would be even more useful if, in some instances, it could get involved in the adjustment process earlier, before layoffs are inevitable. The service, however, is a voluntary one: typically, it is invoked in response to a request from the parties involved. While the IAS does try to make its availability known in situations where there is likely to be a need for its services, resource constraints limit this sort of anticipative marketing.

In our view, there is a substantial and growing market for the adjustment support offered by the IAS. Yet it remains a small program, with annual expenditures of less than $10 million. Therefore, we suggest that the Industrial Adjustment Service be expanded through a gradual increase in its financial and personnel resources.

Part-Time Workers

An important rationale for labour adjustment policy is that the costs of transition are not evenly distributed. Certain groups typically experience relatively unfavourable employment outcomes, and our research suggests that their adaptation to change may be particularly difficult. We have seen some evidence of this for those Canadians with low levels of educational attainment. Older workers, as well, clearly face specific threats due to change. We have also voiced concerns, for example, over the emerging job structure for females. In our view, a national approach to innovation and employment must focus special consideration on those individuals and groups who may be assuming disproportionate transition costs.

One focus of our investigation has involved the relationship between technological innovation and part-time employment. While the new technologies can facilitate flexible alternative arrangements that may be desirable in some cases, at the same time they may well be contributing to involuntary part-time work. Currently, those people who are working part-time – many of whom are women or older workers, or among the young or the disabled – are penalized by not sharing proportionately in the benefits and protection available to full-time employees. This concern applies both to statutory programs, such as unemployment insurance, and to private benefits – most notably private pension-plan coverage. We recognize, however, that the question is complex. For example, some part-time workers place primary importance on immediate cash flow rather than on long-run considerations. And employers, for their part, view such provisions as a source of increased labour costs. In view of the sheer magnitude of part-time work, however, it is clear that the time has come to face this issue.

The Disabled

A final area of specific concern is the situation of disabled persons. Technological change offers tremendous opportunities for advances in the quality of life of disabled persons, in part because of the relaxation of physical job requirements. However, the opening-up of a vast array of working opportunities for the handicapped can be achieved only if employers themselves are informed about how they can cope with special needs. The solutions are often simple and inexpensive, but they are not always obvious to those who have had little experience in dealing with such needs. A central source of expertise and information for companies on how to deal with practical problems involving the disabled could make a very positive contribution towards reducing a gap that is born of lack of awareness and understanding. An interesting example of such an agency is found in the United States in the Job Accommodation Network (JAN). Through a toll-free number, information is provided on often very simple solutions to seemingly complex problems. A similar agency in Canada could supply information on technical aids and architectural modifications; it could provide to prospective clients real-world examples of similar situations and of the solutions developed; and it could recommend types of equipment and sources of supply.

Innovative Management

Objective 4:

For technological change to be successful, Canadians must innovate on two fronts. Success depends as much on innovation in organization and the development of human resources as it does on technical expertise.

Canadian management must become more creative in applying technology, in deploying human resources, and in combining technical and human resources. To be truly effective, the new technologies must be managed as an integrated system, made up of both innovative machinery and equipment and of highly skilled workers.

Innovate on Two Fronts

The educational system has a crucial role to play, not only in the shaping of a labour force that is capable of, and comfortable with, working with the new technologies, but also in producing the managers, scientists, and technicians who play a central role in developing and introducing these technologies. The effective management of technological change has several facets. First, managers must be aware of the capabilities of the new technologies, of the contribution that they can make to their business, and of how best to integrate them with the firm's human capital. Similarly, scientists and engineers who develop technological applications should have an awareness and understanding of the links between technological change and current business needs, and of how technical resources can best be integrated with human resources. In other words, the most successful businesses will be those which have managers with some technical understanding, and scientific and technical staff with some sense of business management. All will have an appreciation for the relationship between human resources and technological change.

Too often, however, the bridges between these skills are conspicuously absent. Steps should be taken, therefore, by Canada's engineering and business schools to produce more fully rounded graduates. We are aware that workloads are already heavy. Interdisciplinary skills, however, are not a luxury – they are a necessity.

Closer Business-Education Ties

Also in need of strengthening are the links between business and the advanced education community. While some steps have been taken in recent years to reduce the gap between those two groups, it remains wide, for the most part. The environment within which the educational system operates has changed a great deal. Demands are being made for a system that is more attuned to the immediate requirements of industry for marketable technology and for specifically trained, but nevertheless flexible, labour market participants. Often, however, there is a very real lack of appreciation for the very different environments within which the business and academic communities operate. On the one hand, business tends to have a very short-term, goal-specific outlook, while the educational system – and universities in particular – traditionally has had a longer-term outlook and a learning rather than a skills orientation.

Cooperative Education and Exchanges

At the same time, both groups could benefit from a closer relationship. This could be accomplished in several ways. For example, we applaud the steps that have been taken in recent years to reduce the insular character of much professional training. Through meetings and discussions, university-industry cooperation on the identification of needs and solutions is being fostered. One group in particular – the Corporate-Higher Education Forum – has been working to promote improved communication between these two communities with respect to professional training and other issues of joint concern.

Another example is that of cooperative educational programs, wherein students alternate periods of schooling with periods of working in their fields. Business benefits by having a relatively inexpensive source of skilled labour; students benefit from the opportunity to apply and modify knowledge gained in an academic environment; and universities benefit from the feedback provided by students who have been exposed to the business world. There is no reason why such a beneficial exchange could not take place at more senior levels as well. Members of both the business and academic communities would gain a deeper appreciation of the environments in which the other works, and both would benefit from having access to the other's skills. For a system of exchange to work, however, participants should not see their career prospects threatened because they remove themselves to another environment for a period of time.

To a certain extent, such exchanges do take place already. But the system is highly dependent upon those rare individuals who successfully combine an enthusiasm for both the academic and business worlds with the flexibility to move comfortably between the two. The growing trend towards the formation of groups of business people to advise on academic programs is a step in the right direction. That step should be taken further to the stage of involvement in the learning and teaching experiences directly.

Strategic Partnering

More use should also be made of other types of cooperative arrangements. For some types of research and technology development, for example, the scale of activity required is very large, surpassing the capabilities of any one group. In such cases, research consortia present an effective alternative. Similarly, joint identification of training needs and capabilities would help businesses and educational institutions to allocate their resources more efficiently and effectively. In the fields of research, technology development, and training, innovative arrangements that tap the skills of both business and postsecondary institutions in a mutually supportive way can bring large payoffs.

Industry and employee associations can play a catalytic and coordinating role in the identification of common industry needs with respect to research and training for the new technologies, and they can act as a go-between, bringing together business, educational institutions, and labour. Community-based efforts that build on local industry and educational strengths can also work towards the same goal.

Elements of Success

We have already emphasized that the theme of innovative management also includes a focus on "soft" technology. Here, the stress is on the management of people, the interaction of managers and workers, and the organization of work. The following key ingredients of an effective and enlightened management style are distilled from our case studies of individual firms:

- pre-planning of both the social and technical aspects of innovation;
- participation by all those who are involved in, and affected by, the innovation process;
- development of more collaborative and flexible work designs and methods;
- commitment to the existing work force;
- retraining and continuing skills development; and
- management training that imparts an understanding of the organizational and human resource consequences of technological developments.

In earlier sections of this Statement, we made public policy proposals relating to a number of these important areas – skills development and management training, for example. It is clear, however, that success will depend ultimately on the initiative of Canadian workers and the innovative approaches of managers, as well as governments. Some practices relating to the key principles set out above have impressed us, and we offer the

Examples of Industrial Training and Retraining Efforts

Company A

Company A was building a state-of-the-art "greenfield" site alongside existing operations that were simultaneously undergoing extensive modernization. The employer and the union had agreed on a staffing approach that gave workers in the existing plants priority for the highly paid jobs in the new one. Moreover, the vacancies created in the process were filled according to an internal bumping procedure. The net result was that virtually all of the employees in the revamped operations required retraining. The systematic planning undertaken to identify such large training needs and to arrange the necessary retraining to meet the production schedule was particularly impressive. The approach used was a "train-the-trainer" method, in which selected operators not only received training in a vocational skill created by the new technology but were also trained to become trainers for that occupation.

Company B

At another plant, efforts have been made to emphasize the ongoing importance of skills development, to raise its visibility, and to improve its accessibility. The importance of training has been underlined by erecting a "learning centre" within the plant. All employees have been allotted a minimum number of training hours per month that can be taken during normal working time, for approved training modules. Such training may involve group instruction in a classroom at the learning centre, individual use of video cassettes, hands-on operation of simulators of new equipment, or familiarization with a computer terminal. Employees also have access to the learning centre on their own time and can borrow from an extensive library of audio and video tapes for use at home.

Company C

In a third company, there is a relatively new development that could complement the kind of facility described in the second example but that, because of its cost effectiveness, has enormous potential for application in education institutions and at home. Known as a computer-based training (CBT) or computer-assisted learning (CAL), it involves a "user-friendly," interactive, self-teaching program that can cover almost any subject at almost any level. From simple database management to typing, from basic mathematics to accounting, the insertion of a disc and a few simple keyboard commands enable the trainee at a terminal to learn at a comfortable pace.

From Betcherman and Newton, "A case book."

following observations to representatives of Canadian business and labour.

Our organization-level research revealed to us the importance of the planning process itself. Effective innovation begins long before any equipment arrives at the company door. We have noted that advance preparation inevitably pays dividends through technological change that works. But the planning must incorporate both the technical and social aspects of innovation. Too often, planning does not go beyond the engineering department, with the consequence that implications for the roles and responsibilities of the work force are inadequately anticipated. However, we did witness, and were impressed by, some cases where the equipment, the production process, the job design scheme, and hence the human resource and training requirements were considered and worked out well in advance. Ideally, all of those involved should take part in comprehensive planning of this type.

As far as on-the-job training is concerned, our case studies uncovered some highly specific but imaginative approaches (see box). The common thread running through them was a managerial commitment to the existing work force.

Mutually Reliant Labour-Management Relations

Objective 5:

If Canadians are to enjoy the fruits of technological progress in a fiercely competitive world, a more constructive industrial-relations climate is essential.

Throughout this report, we have emphasized the "people" side of industrial innovation. A critical issue associated with technological change is the labour-management relationship. There is already considerable pressure on employers, workers, and unions to alter traditional patterns of behaviour. In our view, labour and management in this country need to find ways of working together more effectively.

Both employers and workers should recognize their strong common interests. Above all, they share an interest in a healthy economy – one in which competitiveness and fairness stand side by side. We are aware, as well, that on some issues the interests of the parties cannot always coincide. That is a simple reality of the Canadian system. Where this is the case, labour and management must negotiate constructively in order to find mutually acceptable solutions.

The key is involvement. The record shows that workers and unions in Canada are not opposed to technological change itself, but they are uneasy about the way it is introduced. All of those concerned need to participate in decisions affecting their organization. Where this takes place, people know that their concerns will be addressed; as a consequence, they tend to accept and even appreciate technological and organizational change. The participation of workers and their unions is desirable for social reasons, of course, but evidence from other countries indicates that there are "bottom-line" benefits as well. In Japan and Sweden, for example, institutions – quite different in the two countries – accommodate the involvement of all those with a stake in the outcome. Notably, both countries have adopted the new technologies at a pace and scale beyond Canada's.

While such foreign experiences are instructive, we recognize the importance of "made-in-Canada" solutions. In this country, collective bargaining has developed as the principal means for regulating the labour-management relationship. Thus approaches for strengthening industrial relations in Canada should start from that collective-bargaining cornerstone.

Improve Collective Bargaining

In this study, we have considered the current arrangements with respect to collective bargaining over technological change in some detail. Certainly, there are some examples in Canada of employers and unions negotiating many aspects of innovation to their mutual benefit. In the final analysis, however, our review suggests that there is not a great deal of collective bargaining on technological change and its impact. And where work contracts do contain clauses linked to technological change, they tend to be weakly enforced. Industrial relations systems are effective when the differing interests of the parties are dealt with to the satisfaction of both. Currently, issues associated with technological change are not meeting that standard. In our view, some positive steps can be taken to strengthen the contribution that collective bargaining can make in resolving technology-related issues.

Four jurisdictions in Canada have enacted statutory provisions aimed at encouraging collective bargaining over technological change. Until now, with the partial exception of British Columbia, this legislation does not appear to have succeeded in its objective. That the goals have been better realized in British Columbia is, in our view, at least partly the result of differences between the approach in that province and those of the other

three jurisdictions.* One important difference in the B.C. model is that, in contrast with the other three relevant cases, there is no opportunity for opting out of the legislation's purview. In the federal jurisdiction, for example, the parties are exempted if they have privately negotiated related clauses or if the contract stipulates that the *Canada Labour Code*'s provisions on technological change do not apply.

There are other ways in which the B.C. legislation departs from that of the other jurisdictions. These include a less restrictive definition of what constitutes technological change as well as a procedure for referring technology-related disputes to binding arbitration. We encourage all Canadian jurisdictions to examine British Columbia's legislative approach as a possible means of promoting genuine and positive bargaining over technology-related issues.

Establish Joint Committees

In addition to strengthening the contribution of collective bargaining, it is also important to consider other industrial relations mechanisms for promoting interaction over technological change and its impact. We have noted that formal bargaining over technology, not only here but elsewhere, tends to be somewhat sporadic and, too often, defensive in nature. Furthermore, we must remember that the majority of Canadian workers are outside the collective bargaining system and, consequently, have no formal structures for making their voices heard. As well, a substantial number of unionized workers in the public sector are barred by legislation from bargaining over technological change.

For these reasons, we have carefully considered arrangements that would complement the formal collective-bargaining approach. A number of earlier investigations, notably the federal government's Task Force on Microelectronics and Employment, have concluded that ongoing interaction over technological change would be encouraged through the institution of establishment-level labour-management committees. We also see such committees as potentially useful mechanisms for bilateral discussion of employment-related issues associated with the introduction of new technologies.

These bodies should have a mandate to deal with employment issues (such as job security, wages, retraining, and health and safety) arising in response to technological change. We must emphasize that our intention in making this suggestion is not to circumvent existing collective-bargaining arrangements. It is very important that, in unionized settings, labour representatives be elected from among active union members. The aim of the committees would be to encourage employers and workers to discuss, and seek solutions to, ongoing innovation-related issues.

In Conclusion. . .

It is only realistic to report that technological change is a mixed blessing. It will put pressure on labour markets and it will prove costly for many individuals. We have tried, however, to show where its effects are likely to be felt, and we have tried to suggest actions to help alleviate them. At the same time, we draw attention to the promise that the new technologies hold out in terms of rising productivity, higher quality, greater competitiveness, and increased employment. We have also shown in this Statement that it is possible to use technology while preserving the sense of fairness and tradition of sharing burdens that are characteristic of Canadians.

Canada needs a national policy framework that will stimulate firms, individuals, and governments to develop the capacity to use the new technologies. In short, we believe that Canadians can make technology work.

*As this document was going to press, the Government of British Columbia proposed certain changes in the provincial labour code. We wish to make it clear that our discussion refers to the provisions that existed in April 1987.

Appendix A

The procedure in a nutshell

Step 1: Eliminate the Relative Wage Effect

a estimate labour-input requirements for 1971 and 1981;

b plug 1971 relative wages into the 1981 equations;

c use (b) in conjunction with the 1981 levels and composition of output to calculate the 1981 labour-input requirements for the "no relative wage change" scenario.

Step 2: Eliminate Both the Relative Wage and Tech-Change Effects

a take the 1971 labour-input coefficients (the ratios of labour input per unit of output), which, in comparison with our reference year 1981, contain neither tech change nor relative wage change, by definition;

b use these "no tech change" and "no relative wage change" coefficients in conjunction with the 1981 levels and composition of output to calculate the 1981 labour-input requirements under the "no, no" scenario.

Step 3: Net Out the Tech-Change Effect

Calculate the difference between (1) and (2) to estimate the change in labour-input requirements attributable to the change in technology.

(1)		(2)		(3)
Occupational employment WITH tech change, WITHOUT relative wage effects	–	Occupational employment WITHOUT tech change, WITHOUT relative wage effects	=	Change in occupational employment because of tech change

Table A-1

Sources of Growth in Unit Production Costs, Selected Industries, Canada, 1971-81

	Average annual growth rate in unit production costs	Major sources of increased cost		
		Labour	Materials	Capital
	(Per cent)			
High-tech industries:				
Petroleum and natural gas	25.70			x
Metal mines	13.02	x	x	x
Chemicals and chemical products	11.17		x	x
Finance, insurance, and real estate	10.78	x		
Rubber and plastic products	10.20		x	
Motor vehicles	10.09		x	
Motor vehicle parts and accessories	9.91		x	
Other transportation equipment	9.64		x	
Trade	9.34	x		
Construction	8.98	x	x	
Commercial services	8.50	x		
Machinery	8.39		x	
Electrical products	7.11		x	
Communications	2.82	x		
Mid-tech industries:				
Agriculture	13.35			x
Iron and steel mills	11.62	x	x	
Paper and allied industries	10.75		x	
Coal mines	10.58		x	x
Miscellaneous manufacturing	10.16	x	x	
Nonmetal mines (except coal)	10.08	x	x	
Transportation and storage	9.81	x		
Utilities	8.20			x
Textiles	7.87		x	
Low-tech industries:				
Petroleum and coal products	23.05		x	
Fishing and trapping	15.25	x		
Nonmetallic mineral products	11.16	x	x	
Food and beverages	10.92		x	
Metal fabricating	10.39		x	
Nonferrous metals	10.01		x	
Forestry	9.95	x		
Wood industries	9.80	x	x	
Furniture and fixtures	9.78	x	x	
Leather	9.37	x	x	
Tobacco products	8.11		x	
Printing, publishing, and allied industries	8.05	x	x	
Knitting mills and clothing	7.52	x	x	

Source: Based on data from the Input/Output Division, Statistics Canada, and estimates by the Economic Council of Canada.

Notes

Chapter 1

1 Heather Menzies, *Women and the Chip* (Montreal: Institute for Research on Public Policy, 1981).

2 Labour Canada, *In the Chips: Opportunities, People, Partnerships* (Ottawa: Supply and Services Canada, 1982).

3 Ontario Task Force on Employment and New Technology, *Employment and New Technology* (Toronto: 1985).

4 Economic Council of Canada, *Steering the Course* (Ottawa: Supply and Services Canada, 1984).

5 Robert Kuttner, "The declining middle," *Atlantic Monthly* (July 1983):60-72.

6 Gordon Betcherman and Keith Newton, "A case book on technology and human resources," Economic Council of Canada, Ottawa (forthcoming).

7 Jacquie Mansell, *Workplace Innovations in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1987).

8 Words Associated and Keith Newton, *Workable Futures: Notes on Emerging Technologies*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

Chapter 2

1 For a more detailed discussion of these definitions, see R. W. Riche, D. E. Hecker, and J. U. Burgan, "High technology today and tomorrow: A small slice of the employment pie," *Monthly Labor Review*, U.S. Department of Labor, Bureau of Labor Statistics (November 1983):50-58.

2 For more technical details, see K. McMullen, "What is hi tech?", a paper prepared for the Economic Council of Canada, 1986, mimeo.

3 See Statistics Canada, Science and Technology Statistics Division, *Technology and Commodity Trade*, Catalogue no. 88-503, Occasional, 1984.

4 See Statistics Canada, *Technology and Commodity Trade*.

5 According to the "Sci-tech" definition, which focuses on the producers of high tech, that sector's share of total employment was 25 per cent in 1981, as opposed to our estimate of 53 per cent, which is based on the broader population of the users of high tech.

6 For a more detailed analysis, see T. Siedule and K. Newton, "Sources of industry and occupational employment change," a paper prepared for the Economic Council of Canada (forthcoming).

7 The data cover the business sector of the Canadian economy and exclude all government activities. See Statistics Canada, *The Input/Output Structure of the Canadian Economy in Constant Prices, 1971-1977* (Ottawa: Supply and Services Canada, 1981).

8 See M. Denny, M. Fuss, and J. D. May, "Intertemporal changes in regional productivity in Canadian manufacturing," *Canadian Journal of Economics* 14 (August 1981):390-408.

9 For a more detailed analysis of the cost-efficiency performance of individual industries, see Siedule and Newton, "Sources of change."

10 The six "high-tech" industries were: communications; finance, insurance, and real estate; commercial services; trade; construction; and metal mines.

11 See Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986); also, Chapter 6 of this report.

12 See, for example, Denny, Fuss, and May, "Intertemporal changes," and M. Denny, M. Fuss, and L. Waverman, *The Cost Structure of Manufacturing Industries*, Institute for Policy Analysis, Technical Report no. 12, University of Toronto, 1979.

13 In the 1970s, because of the OPEC oil embargo and the subsequent escalation of energy prices, the crude petroleum and natural gas and the petroleum and coal products industries enjoyed an unexpected boom in business. Market conditions were such that firms could afford relatively high input prices and exploration costs. For that reason, the statistics for the crude petroleum and natural gas industry and the manufacturing of petroleum and coal products are excluded from the calculation of high-tech and non-high-tech sectoral averages, which are used as benchmarks for the evaluation of individual industries' unit production costs.

14 Earlier related work by the Council is discussed in Chapter 5 of its 21st Annual Review. Considerably more detailed decomposition of the sources of industrial and occupational employment change follows in Chapter 3 of this report.

15 This refers to occupation 113/114 in the *Canadian Classification and Dictionary of Occupations* (CCDO). This occupational group includes all managers and administrators in the economy except officials and administrators unique to government.

16 Strictly speaking, there is a third factor, consisting of the interaction between the industry effect and the manpower-mix effect. For a more technical analysis, see Siedule and Newton, "Sources of change."

17 This group includes people in stenographic and typing occupations; bookkeeping, account-recording, and related occupations; office machine and electronic data-processing-equipment operation; material recording,

scheduling and distributing occupations; library, file, and correspondence clerks, and related occupations; reception, information, mail, and message distribution occupations; and other clerical and related occupations.

18 For a detailed description of the technical procedure, and for results for all occupations, see Siedule and Newton, "Sources of change." See also Appendix A of this report.

19 For technical definitions of the terms "labour-saving" and "labour-using," see J. R. Hicks, *The Theory of Wages*, 2nd edition (London: Macmillan, 1963); and J.C.R. Rowley, "Technology, the production function, and unemployment," a report prepared for the Economic Council of Canada (forthcoming).

20 This occupational group includes accountants, auditors, and other financial officers; personnel and related officers; purchasing officers and buyers; nongovernment inspectors and regulatory officers; and occupations related to management and administration, n.e.c.

21 See David L. Birch and Susan J. MacCracken, *The Role Played by High Technology Firms in Job Creation*, MIT Program on Neighborhood and Regional Change (Cambridge, Mass.: 1984).

CHAPTER 3

1 H. Postner and L. Wesa, "Sources of Canadian employment change: A decomposition analysis," a paper prepared for the Economic Council of Canada (forthcoming).

CHAPTER 4

1 For more on this feature, see Tom Siedule and Norman Leckie, "Occupational demand: Estimation and projection," Economic Council of Canada, Discussion Paper 229, Ottawa, May 1983.

2 In fact, it has been shown that a large proportion of the change in occupational employment can be explained by changes in industrial employment; see Richard Freeman, "An empirical analysis of the fixed coefficient 'manpower requirement' model, 1960-1970," *Journal of Human Resources* (Spring 1980). It should also be pointed out that another version of COPS affords users the flexibility of using variable shares in certain industries and regions.

3 See, for example, Employment and Immigration Canada, "Fixed coefficients: Are they accurate predictors of occupational employment?", Labour Market Outlook and Structural Analysis, April 1986, mimeo.

4 For a more detailed description of the demand side of COPS, see Employment and Immigration Canada, "Demand methodology," The Canadian Occupational Projection System, January 1983. For an outline of how the entire model works, see Employment and Immigration Canada, "An overview, an in-depth view," The Canadian Occupational Projection System, January 1983. For another way of projecting occupational employment, see Siedule and Leckie, "Occupational demand."

5 For a more detailed discussion of the Council's outlook into the 1990s, see Chapter 2 of Economic Council of Canada, *Changing Times*, Twenty-Third Annual Review (Ottawa: Supply and Services Canada, 1986).

6 For a discussion of a wide variety of new technologies, see Words Associated and Keith Newton, *Workable Futures: Notes on Emerging Technologies* (Ottawa: Supply and Services Canada, 1986).

7 For a description of the Working with Technology Survey (WWTS) and a detailed analysis of its results for the 1980-85 period, see Chapter 6 of this report.

8 Evans Research Corporation, "The Canadian CAD/CAM market," ERC Paper No. 65, Toronto, August 1985.

9 Thomas McCurdy, "Employment, income and occupational effects of computer-based automation," forthcoming.

CHAPTER 5

1 U.S public policy has been accused of favouring the upper class by cutting their taxes and of penalizing the lower class by cutting transfers. See Bob Kuttner, "The declining middle," *The Atlantic Monthly* (July 1983):60-72.

2 For studies considering these factors, see Lester C. Thurow, "The disappearance of the middle class," *The New York Times*, February 5, 1984; McKinley L. Blackburn and David E. Bloom, "What is happening to the middle class?", *American Demographics* (January 1985):18-25; Sar A. Levitan and Peter E. Carlson, "Middle-class shrinkage?", *Across the Board* (October 1984):55-59; Richard S. Belous, *et al., Middle Class Erosion and Growing Income Inequality: Fact or Fiction?*, Report no. 85-203E, Congressional Research Service (Washington, D.C.: Library of Congress, November 28, 1985); and Katherine L. Bradbury, "The shrinking middle class," *New England Economic Review* (September/October 1986):45-55.

3 The impact of family compositional variables on the distribution of family income in Canada has been quantified by Michael C. Wolfson in "Stasis amid change – Income inequality in Canada, 1965-1983," *Review of Income and Wealth* (December 1986):337-69.

4 For a discussion of occupations, as well as industrial shifts, see Robert J. Samuelson, "Middle-class media myth," *National Journal* (December 31, 1983):2673-78; Robert Z. Lawrence, "Sectoral shifts and the size of the middle class," *The Brookings Review* (Fall 1984):3-11; James L. Medoff and Paul A. Strassman, "About the 'two-tier' work force and growth of low-pay jobs," March 1985, mimeo.; and Neal A. Rosenthal, "The shrinking middle class: Myth or reality?", *Monthly Labor Review* (March 1985):3-10.

5 Wolfson, "Stasis amid change."

6 This somewhat counter-intuitive argument may be explained by the changing composition of the total-family-income package, as employment income fell in importance (because of high unemployment) and as investment and government-transfer income grew (because of high interest rates and slow economic growth). Because of an extensive social safety net and a large concentration of savings among the elderly, a weak economy and tight money have actually had an equalizing effect on the distribution of total family income.

7 See Lars Osberg, "Paying information workers," draft Chapter 3 of *The Information Sector: Unbalanced Growth and Its Implications*, ed. Lars Osberg *et al.*, Institute for Research on Public Policy (forthcoming).

8 According to Osberg's paradigm, there are: occupations involved in goods production (e.g., machining, forming), which are subject to increases in labour productivity because of improvements in technology; personal-service occupations (e.g., food serving), in which labour productivity is inherently unable to increase because labour time itself is the output; data-based occupations (e.g., clerical), which are involved in the production of data and are subject to rapid increases in labour productivity because of a decline in computing and telecommunications costs; and knowledge-based occupations (e.g., scientists), which require human intervention in the generation of knowledge and in which there is no trend towards increasing labour productivity.

9 See Tom Siedule, "Notes on the declining middle," Economic Council of Canada, March 18, 1986, mimeo.

10 For some discussion of the skill-polarization issue, see Robert T. Lund and John A. Hansen, *Keeping America at Work: Strategies for Employing the New Technologies* (New York: Wiley & Sons, 1986) pp. 100-108.

11 See Keith Newton and Norm Leckie, "The employment effects of technological change," in *New Technology, Work and Employment*, forthcoming in Autumn 1987.

12 This conclusion is based on consultations with a contributor to this research at Statistics Canada.

13 The ensuing analysis draws heavily on work done in collaboration with the Social and Economic Studies Division of Statistics Canada.

14 A census family is, in essence, a nuclear family composed of at least a head, possibly a spouse, and possibly unattached children living at home; a "family" of one person would be an "unattached individual." Each family unit is identified by the family income, size, and marital/fertility status (single, married; with or without children). The head, spouse (if one exists), and unattached individual is furthermore identified by age, sex, education, occupation, industry, and employment status (for example, employed full-time or unemployed). For more details on the SCF, consult Statistics Canada, *Income Distributions by Size in Canada*, Cat. no. 13-207, 1984.

15 This was done by treating a family unit with a head and a spouse as two individual records. Missing from the analysis, then, would be those children still living at home who are working.

16 This is a prototype developed by Michael Wolfson, "Polarization, inequality and the disappearing middle," Statistics Canada, Ottawa, April 7, 1986 (draft).

17 Eliminated from the analysis are those with only minimal labour force attachment – that is, those earning no more than 2.5 per cent of the average industrial wage. This leaves a work force of effective labour force participants (ELFP) that is, strictly speaking, just a sub-sample of the population at large and may not, therefore, reflect national population breakdowns. Moreover, it is not clear whether or not all results obtained are statistically significant, since in some cases (e.g., the 65-plus age group), the sample size may be small.

18 The employment status classifies an individual as either working full-time/full-year or working less-than-full-time/full-year. The latter group, therefore, includes those working on a full-time basis but only for part of the year. Thus its work-force share in this sample exceeds the part-timers' employment share in the population at large, as defined by the Labour Force Survey, which classifies only those working on a part-time basis as part-time.

19 Because the nature of the occupational and industrial questions on the Survey of Consumer Finances changed after 1971, the analysis in this table must begin in 1975.

20 It should be borne in mind that these are broad occupational groupings. The so-called higher-qualified managerial and professional categories include a number of low-skilled occupations, particularly in medicine (e.g., hygienists).

21 See Don Allan, "Analysis of the steel industry labour market and the adjustments facing its work force," a paper presented to the Canadian Steel Trade Conference, Sault Ste. Marie, Ontario, May 5-7, 1985.

22 J. Paul Grayson, *Plant Closures and De-Skilling: Three Case Studies*, Science Council of Canada (Ottawa: Supply and Services Canada, 1986).

23 Further analysis, which will be reported in a forthcoming background study, will examine trends in the distribution of income to 1986. That analysis will be based on the most recent census data, which were not available at the time of writing this report.

CHAPTER 6

1 Charles Killingsworth, quoted in M. M. Towy-Evans, "The value and applicability of case studies," in International Labour Office, *Automation: A Discussion of Research Methods* (Geneva: ILO, 1964), p. 42.

2 It should be noted that the number of case studies of technical innovation in Canada has increased significantly in recent years. The major impetus for this has been the financing of research on impacts of technological change through Labour Canada's Technology Impact Research Fund.

3 For a summary of the results, see Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

4 A small percentage of establishments in the service industries reported special applications of process-type automation. With the exception of CAD in business services, these applications differ fundamentally from what is more commonly perceived as factory automation and are not reported here.

5 For a more detailed discussion of future trends, see Chapter 4.

6 A drawback in defining innovators simply as any establishment that introduced computer-based technologies from 1980 to 1985 is that it excludes those cases where substantial computer-based automation took place prior

to 1980. In its early days, computer-based automation was most suited to large-scale, process industries, such as chemicals, and to very large data users, such as large insurance companies, for which mainframe computers were affordable. It is only more recently that microchip-based automation has become available, reducing the cost of the technology and encouraging its diffusion.

7 These results correspond quite closely to earlier findings regarding Canadian manufacturing industries with high and low "technological opportunity." See Economic Council of Canada, *The Bottom Line* (Ottawa: Supply and Services Canada, 1983), p. 43.

8 The lack of a clear relationship is consistent with the recent literature. While large establishments are better able to reduce the risk associated with technological innovation, the flexibility of small establishments apparently enhances their ability to innovate. See Economic Council of Canada, *The Bottom Line*, p. 40.

9 Economic Council of Canada, *The Bottom Line*.

10 Economic Council of Canada, *The Bottom Line*.

11 J. R. D'Cruz and J. D. Fleck, "The 1986 EMF scorecard on Canada: Mixed, but encouraging," *Business Quarterly* 51, no. 2 (Summer 1986):78-87.

12 Evans Research Corporation, "The Canadian CAD/CAM market," ERC Paper no. 65, Toronto, August 1985.

13 Ontario Ministry of Industry, Trade and Technology, *Flexible Automation Equipment* (Toronto: ITT, 1985), p. 9.

14 R. Jaikumar, "Postindustrial manufacturing," *Harvard Business Review* 64, no. 6 (November-December 1986):69-76.

15 M. Mine, "The social impact of microelectronics in Japan," *International Labour Review* 125, no. 4 (July-August 1986):473-97.

16 A few cautionary notes with respect to the interpretation of the available evidence must be sounded. The Canadian evidence is taken from the Working with Technology Survey, which covered the period 1980-85. In the cases of some firms and industries, computer-based technology was introduced prior to 1980. To this unknown degree, then, our estimates of the extent of use in Canadian industry understate the true picture. At the level of the economy as a whole, and even at the industry-sector level, however, the size of this underestimation should not be significant. On the other hand, the WWTS was a mail survey, and it is known that responses to surveys of this type tend to be biased somewhat toward positive responses. In other words, it is likely that, in this sense, the WWTS provides an overestimation of the extent of introduction of computer-based technologies in the 1980-85 period, again by an unknown amount. This inability to know fully the nature of non-respondents to a survey is common to all surveys, however, and for that reason the surveys reported in this section should be interpreted as indicators only rather than as descriptions of the precise state of industries at given points in time.

17 J. Northcott and P. Rogers, *Microelectronics in Industry: An International Comparison - Britain, Germany, France*, no. 635 (London: Policy Studies Institute, 1985).

18 Northcott, *Microelectronics in Industry*, p. 22.

19 It is of interest to note - and some subtle issues are raised - when the problems cited by innovators are compared with those cited by non-innovators. In every single case, a larger percentage of innovators cite the difficulty. This suggests two conclusions. First, the difficulties associated with innovation are not insurmountable. Second, and more subtly, these differences suggest that the innovation gap may be larger than appears on the surface; it may be that many non-innovators are so far behind in the process that they do not even know what the problems are. This also suggests that there may be a certain level of disinterest in technological change among non-innovators.

20 Some of the major users of computer-based technologies have decided to solve this particular problem themselves. General Motors, for example, launched a major program some time ago, called MAP (Manufacturing Automation Protocol), to design systems to enable integration of different types of computer-based automation. Despite many of the claims made for fully automated factories and offices, the state-of-the-art has not really progressed to the stage of computer-integrated manufacturing (CIM), from the perspective of most firms. Equipment sold by different vendors often cannot communicate; and, in any event, only in specialized cases are whole factories or offices scrapped. Instead, existing equipment with some useful life left in it is usually kept in operation.

21 The Technology Impact Research Fund was established by Labour Canada in 1983 to finance research into the social and human impacts of technological change in the workplace. Some of the early studies are summarized in Labour Canada, *Technology Impact Research Fund: Project Results* (Ottawa: 1986).

22 Based on an unpublished case study prepared for the Economic Council by STS Organization Design Associates, Montreal, 1986.

23 The literature on the skill impacts of technological change is voluminous. For a comprehensive review, see Kenneth Spenner, "Deciphering Prometheus: Temporal change in the skill level of work," *American Sociological Review* 48 (1983):824-37. Prominent expressions of the "deskilling" viewpoint include Harry Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974); and Harley Shaiken, *Work Transformed: Automation and Labor in the Computer Age* (New York: Holt, Rinehart, and Winston, 1984).

24 U.S. Office of Technology Assessment, *Computerized Manufacturing Automation: Employment, Education, and the Workplace* (Washington: U.S. Congress, OTA-CIT-235, April 1984), Chap. 5.

25 Among survey respondents reporting data by sex, 16 per cent of females and only 12 per cent of males were working directly with computers in 1985.

26 Remarks by Peter Urban of the Canadian Institute of Metalworking, as quoted in the *Globe and Mail*, January 22, 1986.

27 Based on an unpublished case study prepared for the Economic Council by James Jacobs, 1986.

28 "Statistical process control" refers to the use of basic statistical concepts to monitor how consistently products fit engineering specifications. For nontechnical definitions and brief overviews of a range of new technologies and related technical terms, see Words Associated and Keith Newton, *Workable Futures* (Ottawa: Supply and Services Canada, 1986).

29 For example, mixed training was more typical of programs reported for machining and product fabricating, assembly, and repair occupations (57.7 and 55.8 per cent, respectively) than for all programs (33.1 per cent).

30 Postsecondary education institutes were cited as a source in 36 per cent of recruiting cases reported by survey respondents. This source is less important for more generalized recruiting. See Gordon Betcherman, *Meeting Skill Requirements*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1982).

31 Often the reduction in the number of workers required per unit of output can be of several orders of magnitude. These reductions have been most evident in Japan, where, it is argued, the utilization of microelectronics-based equipment, particularly in the manufacturing sector, has been most effective. See Jaikumar, "Postindustrial manufacturing."

32 Richard E. Walton, "From control to commitment in the workplace," *Harvard Business Review* (March-April 1985):77-84.

CHAPTER 7

1 Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

2 Bjorn Gustavsen, at the International Workshop on New Technology and New Forums of Work Organization, German Democractic Republic, Berlin, 9-12 November 1986.

3 Jacquie Mansell, *Workplace Innovation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1987).

4 Sally R. Luce, *Building Quality Through People*, Compensation Research Centre Report 03-85 (Ottawa: Conference Board of Canada, 1985).

5 Mansell, *Workplace Innovation*, argues that, paradoxically, the fullest development of STS may only be possible where union and management are both present and both committed to fundamental change.

6 See Mansell, *Workplace Innovation*, for a brief description and a number of references.

7 K. G. Waldie, "The evolution of labour-government consultation on economic policy" in *Labour-Management Cooperation in Canada*, ed. C. Riddell (Toronto: University of Toronto Press, 1986), p. 189.

8 Canadian Labour Market and Productivity Centre brochure, Ottawa, November 1985.

9 International Workshop on New Technology and New Forums of Work Organization, German Democratic Republic, Berlin, 9-12 November 1986.

10 Labour Canada, *A Survey of Part-Time Employment in Federally Regulated Industries*, vol. 1 (Ottawa: Labour Canada, December 1985), p. 34. This survey elicited responses from 1,950 out of 4,940 known federally regulated companies in Canada, covering 555,328 (81 per cent) of 686,509 employees known to be working in federally regulated firms. Some of the detailed results are based on a core group of 270 companies (469,682 workers) who supplied such information.

11 See Betcherman and McMullen, *Working with Technology*.

12 Labour Canada, *Part-Time Work in Canada: Report of the Commission of Inquiry into Part-Time Work* (Ottawa: Supply and Services Canada, 1983), p. 42.

13 Labour Canada, *Part-Time Work in Canada*, p. 35.

14 Part of the differential may be explained by the fact that part-time jobs are concentrated in industries and occupations that generally pay lower hourly rates (Labour Canada, *Part-Time Work in Canada*, p. 76). In fact, another analysis indicated that, adjusting for differences in characteristics, between part-time and full-time workers and in selection bias, the wage differential was only one-third of the unadjusted differential. See Wayne Simpson, "Analysis of part-time pay in Canada," *Canadian Journal of Economics* 19, no. 4 (November 1986):798-807.

15 This would justify a claim that the lack of benefit coverage for part-time workers is a form of discrimination. See House of Commons, *Equality for All*, Report of the Parliamentary Committee on Equality Rights, Issue 29 (Ottawa: October 1985), p. 95.

16 Labour Canada, *Survey of Part-Time Employment*.

17 For corroboration, see Virginia Galt, "Concern is rising about treatment given to part-timers," *Globe and Mail*, April 21, 1986; and Robin Schiele and Bruce Gates, "Some firms prorate part-timers' benefits," *Financial Post*, August 3, 1985.

18 Still, unions accept the existence and utility of part-time employment in certain circumstances but would like to see part-time workers receive the same pay and benefit rates, and accumulated seniority, as full-time workers. They would also like to see reform of such legislation as the *Public Service Staff Relations Act*, which denies union membership to a large number of part-timers. As well, they feel that the prescription by some provincial jurisdictions of separate bargaining units for part-time workers should be eliminated. The union viewpoint is contained in *Facts*, "Part-time work: More part-timers mean more problems, challenges," November-December 1985:18-9; Labour Canada, *Part-Time Work in Canada*, and *Canadian Labour*, "CLC agrees with part-time work report," October 1983:12.

19 There are some disadvantages unique to job sharing. Some employees experience difficulty in accomplishing job requirements without extending their work into their leisure time. In addition, employers have experienced communication, compatibility, and job-continuity problems between sharers. Finally, job sharing is likely to increase hiring, training, and supervisory costs. Labour Canada, *Part-Time Work in Canada*, p. 184.

20 This finding was similar to that of the Public Employers of British Columbia that job-sharing arrangements have favourable results. See Public Employers of British Columbia, "Alternative schedules: An analysis of work sharing and job splitting techniques," Reference Report no. 78, Vancouver, March 19, 1983.

21 Labour Canada, *Part-Time Work in Canada*, p. 174.

22 For a fuller description, see David A. Bratton, "Moving away from nine to five," *Canadian Business Review* (Spring 1986).

23 Employment and Immigration Canada, *Evaluation of the Work Sharing Program*, Program Evaluation Branch (Ottawa: CEIC, 1984), p. 3.

24 Because those on work sharing are not counted as unemployed in official statistics, the published unemployment rate is artificially low. See Noah M. Meltz and Frank Reid, "Reducing the impact of unemployment through work-sharing: Some industrial relations considerations," *The Journal of Industrial Relations* 25, no. 2 (June 1983).

25 See CEIC, "Evaluation," p. vi.

26 See "Time spent working," in *Work and Pay: The Functioning of Labour Markets*, Chapter 15 of Report of the Royal Commission on the Economic Union and Development Prospects for Canada, vol. 2 (Ottawa: Supply and Services Canada, 1985), pp. 645-55.

27 See *Job Creation Training and Employment Services*, a Study Team Report to the Task Force on Program Review (Ottawa: Supply and Services Canada, 1985).

28 See Claude Forget, Commission of Inquiry on Unemployment Insurance, *Report* (Ottawa: Supply and Services Canada, 1986), pp. 161-62.

29 On the other hand, home working also appears to typify elements of the opposing scientific management school, since there is reduced feedback, less social contact, and less opportunity to form work groups.

30 Margrethe H. Olson and Sophia B. Primps, "Working at home with computers: Work and nonwork issues," *Journal of Social Issues* 40, no. 3 (1984).

31 Ursula Huws, "New technology homeworkers," *Employment Gazette* (January 1984).

32 See "Reductions in working time," *Worklife* 4, no. 2 (1985):10.

33 Another way to reduce weekly hours is to put a limit on overtime, since employers may respond to a cut in hours, not by hiring additional workers to pick up the slack, but by increasing overtime among their existing staff. Indeed, the Ontario government has set up the Ontario Task Force on Hours of Work and Overtime, the purpose of which is to consider the feasibility of legislatively reducing overtime in order to create jobs for the unemployed. For more on this Task Force, see Wilfred List, "Efforts to restrict overtime rekindled," *Globe and Mail*, March 17, 1986; and Morley Gunderson, "Task force on overtime options," *Labour Relations News* (September 1986).

34 Much of the following is taken from Shiela Gariepy Kelly, "Attitudes toward working hours changing," *Canadian Business Review* (Spring 1986), and Prem Benimadhu, *Hours of Work: Trends and Attitudes in Canada*, Compensation Research Centre Report no. 18-87 (Ottawa: Conference Board of Canada, 1987).

35 For a discussion of this issue in more detail from a macro point of view, see J. D. Whitley and R. A. Wilson, "The impact on employment of a reduction in the length of the working week," in *Cambridge Journal of Economics* 10 (1986):43-59. A micro perspective can be found in Roberto Zachmann, "Reduction of working time as a means to reduce unemployment: A micro-economic perspective," *International Labour Review* 125, no. 2 (March-April 1986):163-75.

36 This, in fact, was the European experience, as documented in Whitley and Wilson, "The impact on employment," p. 45; and Frank Reid, "Combatting unemployment through work time reductions," *Canada Public Policy* 12, no. 2 (June 1986):275-85.

37 For a summary of union views, see Sam Gindon, "Reduced work-time: A union perspective," *Canadian Labour* (November-December 1984); and Canadian Labour Congress, *Give Me a Break* (Ottawa: CLC, 1986).

38 This assumes that a cut in standard hours will be enforceable in all sectors of the economy.

39 When comparing these results with those of a similar simulation effort in TIM - another major macroeconomic model - the picture is about the same, though with less severe effects on the trade balance, mainly because less responsiveness to prices has been built into that model. This simulation is described in Mark Haney and M. C. McCracken, "The macroeconomic effects of a one-hour reduction in the standard work-week," NFS Special Study 86-05 (Ottawa: Informetrica, 1986).

40 See Employment and Immigration Canada, *Canadian Jobs Strategy: Working Opportunities for People* (Ottawa: CEIC, June 1985).

41 See "Time sharing means jobs," a brochure put out by the Quebec Ministère de la Main-d'oeuvre et de la Sécurité du revenu, Montréal, Québec.

42 This information was obtained by phone from the program's co-ordinator, Christian Côté, January 1987.

CHAPTER 8

1 Jack Barbash, "Do We Really Want Labor on the Ropes?", *Harvard Business Review* 63, no. 4 (July-August 1985):10-20.

2 See, for example, the comments of Edmond Maire, General Secretary of the French Democratic Confederation of Labour, quoted in *ILO Information* 22, no. 1 (February 1986), pp. 1, 6.

3 Morley Gunderson and Noah M. Meltz, "Canadian Unions Achieve Strong Gains in Membership," *Monthly Labor Review* (April 1986):48-49. See, as well, Joseph B. Rose and Gary N. Chaison, "The state of the unions: United States and Canada," *Journal of Labor Research* 6, no. 1 (Winter 1985):92-111.

4 In this context, the union/management relationship is being reconsidered. The "new industrial relations" model is a term coined by U.S. observers to capture the changing strategic approach to labour that is being adopted by

many employers in that country. The thinking behind this approach is that employees will not want a union if they are treated properly. Competitive wages and working conditions are offered, and considerable attention is also given to "human-resource management" – the development of organizational structures designed to increase the participation and commitment of the workers. See Thomas A. Kochan and Michael J. Piore, "Will the new industrial relations last? – Implications for the American labor movement," *The Annals of the American Academy of Political and Social Science* 473 (May 1984):177-89.

5 Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

6 Michael J. Piore and Charles F. Sabel, *The Second Industrial Divide: Possibilities for Prosperity* (New York: Basic Books, 1984).

7 Pradeep Kumar with Mary Lou Coates and David Arrowsmith, eds., *The Current Industrial Relations Scene in Canada, 1986* (Kingston: Queen's University Industrial Relations Centre, 1986), pp. 309-11.

8 Thomas A. Kochan, *Collective Bargaining and Industrial Relations* (Homewood, Ill.: Irwin, 1980), p. 58.

9 See Harley Shaiken, *Work Transformed: Automation and Labor in the Computer Age* (New York: Holt, Rinehart, and Winston, 1984).

10 This argument follows from Piore and Sabel, *The Second Industrial Divide*.

11 European Foundation for the Improvement of Living and Working Conditions, *The Role of the Parties Involved in the Introduction of New Technology* (Dublin: European Foundation, 1985).

12 *ILO Information* 22, no. 1 (February 1986):5.

13 Information on the poll comes from a seminar presentation of the results in Ottawa, September 1985.

14 Stephen G. Peitchinis, "The attitude of trade unions towards technological changes," *Relations industrielles* 38, no. 1 (1983):104-19.

15 Peitchinis, "The attitude of trade unions," p. 111.

16 Gordon Betcherman, "Results of the USWA technology survey, May 1983," unpublished paper, 1985. A summary of this report was published in the proceedings of the *Steelworkers' Canadian Policy Conference*, (Toronto: 1985).

17 In this connection, it is also worth noting that according to the Council's Working with Technology Survey, innovation appears to be more frequent in larger firms (those employing over 500 workers). For instance, 98.9 per cent of the "large" establishments reported introducing some computer technology between 1980 and 1985, compared with 54.9 per cent of establishments employing 50 or fewer workers and 75.5 per cent for the sample as a whole. The fact that large establishments are more apt to introduce technological innovations may well have something to do with the greater frequency of technology clauses found in large bargaining units.

18 The Canadian Labour Congress has long advocated a one-year notice period. But according to the Labour Department data, only three agreements in the large agreement pool (well below 1 per cent of the total) covering 4,800 workers (0.2 per cent of all "large agreement" workers) contained a notice period of that duration as of 1985.

19 The Canadian Labour Congress believes workers should have protection in all the areas covered in Table 8-4. See Canadian Labour Congress, *Tech Change: A Handbook for Negotiators* (Ottawa: CLC, 1982).

20 In dealing with time-series data, we must assume that the data pool is more or less constant from year to year or, at least, that the new agreements added to the pool are reasonably comparable to those deleted from it (as is the case when layoffs or plant closures reduce employment levels at a given workplace below 500).

21 For details on how to calculate this and various other "across-the-agreement" aggregate tech-change measures, see Jonathan Peirce, "Toward a tech-change rating system," Studies in Communications and Information Technology Working Paper Series, Queen's University, Kingston (1987).

22 Here it should be noted that relocation allowances are probably more important bargaining items for workers in transportation and communications industries, who are transferred fairly routinely, than for those who, like pulp and paper workers, tend to be more attached to a particular geographical region.

23 When all 10 Canadian provinces were included, the correlation was 0.82. When Prince Edward Island was dropped (only four large agreements are from that province), we attained a correlation coefficient greater than 0.90.

24 It is possible, of course, that technology-specific clauses may not be necessary in contracts where general protective clauses (notice-of-layoff, for example) exist. No strong relationship was found between these types of provisions.

25 The sampling procedure involved the selection of 183 contracts, roughly one-tenth of the Collective Bargaining Division's active, non-construction agreements covering fewer than 500 workers. As Labour Canada does not code small-unit agreements, this exercise involved examination of each contract.

26 These included restrictive-definition clauses (definitions restricted to equipment only), as well as broad ones (relating to changes in work methods, as well as in equipment). Thus the 5 per cent figure may overstate the incidence of favourable definition-clause protection. A more realistic figure might be 2.7 per cent (the incidence of broader tech-change definitions). For a fuller discussion of the definition issue, see Peirce, "Tech-change rating system," pp. 15-17.

27 Employer resistance to legislated technological change protection is not a new phenomenon. An article in the January 1972 issue of *Canadian Labour* (pp. 10-11) quoted a Canadian Labour Congress submission to Labour Minister Bryce Mackasey regarding the proposed technological change provisions to this effect: "We have noted with considerable interest the objections raised by employer spokesmen against the inclusion in the bill of

any provisions dealing with technological change. . . their insistent demands to have the present proposals withdrawn in their entirety. . . . It seems to us that what they really fear most is the upsetting of the grail of management's so-called residual rights if the provinces should follow the example of the federal government and enshrine the principle of bargaining on technological change in their legislation."

28 See the Canada Board's decision, written by James Dorsey, in *Ottawa-Carleton Regional Transit Commission* [1982] 1 Can. L.R.B.R. p. 172. This case's review of previous cases is discussed in K. McGuire, *Technological Change Clauses in Practice* (Ottawa: Canadian Labour Congress, 1983), pp. 2-3.

29 This information was provided by the Saskatchewan Labour Department in 1985.

30 These cases include *Acklands Ltd.* [1976] 1 Can. L.R.B.R. 71; *Tahsis Company Ltd.* [1979] 2 Can. L.R.B.R. 377; *Eurocan Pulp & Paper* B.C.L.R.B. No. 62/82, especially paper 288-301, and reconsidered in the union's favour in 1983; and *Carling O'Keefe Ltd.* B.C.L.R.B. No. 249/86.

31 See CLC, and McGuire, *Technological Change Chance*, pp. 2, 4-7.

32 Quoted in McGuire, *Technological Change Clause*, p. 4. See also *Forest Industrial Relations* [1974], W.L.A.C. 207 at p. 210, in which the arbitration panel ruled that bringing a boiler back into operation was not a technological change, even though it led to the layoff of an underqualified operating engineer. This case is described by McGuire at p. 5.

33 *Canada Post Corporation and Canadian Union of Postal Workers* (1985), CUPW #N-1000-GG-44 (Swan).

34 *Re Canadian Union of Postal Workers and Treasury Board*, PSSRB #169-2-149, Aug. 9, 1978 (Beatty).

35 *Governing Council of University of Toronto and Canadian Union of Public Employee, Local 1230*, unexported decision of arbitrator, Hinnegan, released 1984.

36 In some instances, it should be noted, arbitrators have adopted a broader definition of technological change. Such a definition was adopted in two Quebec cases involving Canada Post: *Re Canada Post Corporation and Canadian Union of Postal Workers*, C.P.C. #82-2-3-12, CUPW #N-1000-GG-12, June 29, 1983 (Dulude); and *Re Canada Post Corporation and Canadian Union of Postal Workers*, C.P.C. #83-2-3-8, CUPW #1000-GG-19, March 1, 1985 (Blouin). In the latter case, which involved quite similar issues to those posed in the "phantom codes" case, arbitrator Rodrigue Blouin rejected Beatty's narrow definition of technological change, arguing that if any one of the three conditions in Article 29 of the Canada Post agreement were satisfied, a technological change would have occurred. And in *Re Metropolitan Toronto Library Board and Canadian Union of Public Employees, Local 1582*, unreported decision of arbitrator Picher, rleased 1982, the arbitrator ruled that the introduction of *less* advanced equipment resulting in the demotion of a computer programmer should be considered a technological change, in the absence of specific agreement language to the contrary. This is one of the few cases we are aware of in which the absence of a precise definition of technological change has helped rather than hurt a union.

37 *Prince Rupert Grain Terminal Ltd.* (1984) Can. L.R.B.R. (NS) 1.

38 The Board ruled that due and proper notice had been given by the employer on August 31, 1984, in a letter sent after the union had filed its application with the Board, and that therefore the employer would have to wait 120 days from September 1, 1984 (the day on which notice was presumably received by the union). But since the Board's decision was not issued until Dec. 12, 1984, this meant that the employer could implement the change less than three weeks after the decision, on January 1, 1985. The Board did find that the union's certification extended to represent employees at the new terminal.

39 Quoted in Patricia McDermott, "Canadian labour law and technological change: An Overview," unpublished paper, 1985, p. 7.

40 See McDermott, "Canadian labour law," p. 8. Where there are two to nine employees, only a layoff of two or more will be considered significant; where there are 10 to 19, a layoff of three or more will be significant. This means, as McDermott notes, that the Saskatchewan law essentially excludes a situation in which only one employee is affected by a change.

41 *Grain Services Union and Manitoba Pool Elevators* 85 C.L.L.C. 16,061 (Can. Lab. Rel. Bd.).

42 See also the *Pacific Western Airlines* case [1977] 2 W.L.A.C 259, discussed by McGuire in *Technological Change Clause*, pp. 10-11. Here, the arbitration board ruled that assigning customer service agents the job of inserting flight movement information directly into a new computer system rather than having the agents send messages to dispatchers, who would then control that information, led to employment effects "too minimal to affect the security and integrity of the dispatchers."

43 For instance, this occurred in *Canadian Newspapers* (1980), 29 L.A.C. 85, discussed in Mcguire, *Technological Change Clause*, p. 8.

44 McGuire, *Technological Change Clause*, pp. 8-9.

45 *Manitoba Museum of Man and Nature and Manitoba Government Employees' Association*, unreported decision of arbitrator Sigurdson, released 1986.

46 These reasons are not, however, elaborate on in the Board's decision. It should be noted that the B.C. Labour Code excludes only those in management or confidential industrial relations from collective bargaining rights.

47 The B.C. definition is basically the same as that used by Blouin (see note 36), who argued that a technological change exists if any one of the three relevant conditions is fulfilled, rather than that of Beatty or Swan (see notes 33 and 34), who argued that all three conditions must be fulfilled.

48 Most notably in the Eurocan case (see note 30).

49 See, for instance, *Rayonier Canada Ltd.* [1978] 1 W.L.A.C 224, esp. p. 235. This case is discussed by McGuire *Technological Change Clause*, pp. 6-7 and by McDermott, "Canadian Labour Law", p. 6.

50 For instance, in *City of Port Moody* [1977] 1 W.L.A.C 238, the arbitration board held that the layoff of two boat ramp attendants should be considered "significant" because it wiped out a portion of the bargaining unit. This ruling is in sharp contrast to the one made by CLRB Vice-Chairman Brian Keller in the 1985 *Manitoba Pool Elevators* case mentioned earlier (see note 41). In the very recent Carling O'Keefe case (see note 30), B.C. Board Vice-Chairman Wayne Moore offers an excellent discussion of the concept in his ruling in the union's favour.

51 It should be noted, however, that the Board cautioned that its ruling in the *Tahsis* case should not be considered a precedent in other cases involving work stoppages.

52 There is considerable difference of opinion on whether productivity gains from new technology should be claimed as increased wages or added leisure time. While different workers within the same country, and even the same worker at different stages in his career, might well make a different choice between work and leisure, some evidence from the European Community suggests that workers in decentralized industrial-relations systems characterized by business-style unionism and wage negotiation at the enterprise level are more apt to favour increased wages, whereas workers in countries with centralized systems are more likely to favour increased leisure time.

53 International Labour Office, *Technological Change: The Tripartite Response, 1982-85*, hereafter referred to as "ILO, *Casebook*" (Geneva: ILO, 1985), pp. 37-38.

54 ILO, *Casebook*, pp. 8-9.

55 Kevin Murphy and Dennis Chamot, "Technological change clauses in collective bargaining agreements," in *The Critical Communications Review*, ed. Vincent Mosco and Janet Wask (Norwood, N.J.: Ablex, 1983), pp. 245-78.

56 Thomas R. Knight and David C. McPhillips, "Public policy and collective bargaining responses to new technology in Canada," a paper presented to the 39th meeting of the IRRA, New Orleans, 1986.

57 George Ruben, "UAW, GM-Ford contracts focus on saving jobs," *Monthly Labor Review* (December 1984):46-49.

58 R. Williams and F. Steward, "New technology agreements: An assessment," in *Industrial Relations Journal* 16, no. 4 (1985): 58-73.

59 Williams and Steward, "New Technology agreements."

60 See Malcolm Warner, "Worker participation and employee influence: A study of managers and shop stewards," *Industrial Relations Journal* 13, no. 4 (1982):19ff. But note also that J. Northcott and P. Rogers, in *Microelectronics in Industry*, No. 635 (London, England: Policy Studies Institute, 1985), indicate that, in practice, the British workers under study were consulted more frequently about tech change than comparable West German workers.

61 Edythe Epstein, "Negotiating over technological change in banking and insurance," *International Labour Review* 123, no. 4 (July-August 1984):405-22.

62 See Stephen Deery, "New technology, union rights and management prerogatives: The Australian experience," in *Labour and Society* 11, no. 1 (1986):67-82.

63 Deery, "The Australian experience."

64 The most notable of these awards was one involving the Federal Clerks' Union of Australia. In 1980, the Industrial Relations Commission for the state of Victoria altered the union's arbitration award by inserting a new technological-change clause requiring advance notice, consultation during any feasibility investigation, and information sharing. See Deery, "The Australian experience," p. 75, for a more detailed discussion of this and similar cases.

65 Deery, "The Australian experience."

66 Koji Okubayashi, "Recent Problems of Japanese Personnel Management," *Labour and Society* 11, no. 1 (January 1986):17-37.

67 ILO, *Casebook*.

68 M. Mine, "The Social Impact of Microelectronics in Japan," *International Labour Review* 125, no. 4 (July-August 1986):473-97.

69 Steven Deutsch, "International experience with technological change," *Monthly Labor Review* (March 1986):35-40.

70 See ILO, *Casebook*, pp. 200-203.

71 ILO, *Casebook*, pp. 200-201.

72 From Friedrich Fürstenberg's chapter on Germany, in *Technological Change and Industrial Relations: An International Symposium*, ed. G. Bamber and R. Lansbury (Kluwer: Deventer, 1983). This was a special issue of the *Bulletin for Comparative Labour Relati[illegible]lletin* 12.

73 The German situation is, indeed, something of a crazy quilt. For instance, the Federal Labour Tribunal has ruled that works councils have no general rights to codetermination regarding the layout of VDT workplaces. The same tribunal has ruled that the councils did have codetermination rights in a case involving computerized supervision in a customer service department. And the Baden-Württemberg Labour Court ruled that a works council must be consulted when a company plans to introduce CAD systems. On the other hand, the federal tribunal ruled no codetermination need apply in a case where a large Baden-Württemberg company proposes to install an electronic system to control entry to its premises. See ILO, *Casebook*, pp. 152-55.

74 Russell Lansbury, "Technological change and industrial relations: An international comparison," a paper presented to the 39th meeting of the IRRA, New Orleans, 1986.

75 Rianne Mahon, "Technological change and labour market policy: The United States, Japan, West Germany, and Sweden," Economic Council of Canada, unpublished document, 1986.

76 Folke Schmidt, *Law and Industrial Relations in Sweden* (Stockholm: Almqvist & Wiksell International, 1977), esp. pp. 78-85, on the *Act for the Joint Regulation of Working Life*.

77 Robert Howard, "UTOPIA: Where workers craft new technology," *Technology Review* (April 1985):43-49.

78 Deutsch, "International experience."

79 Mahon, "Technological change."

80 Roy J. Adams, "The extent of collective bargaining in Canada," *Relations Industrielles* 39, no. 4 (1984):655-67.

81 Alberta, Ontario, and the Maritime Provinces are the jurisdictions that exclude the largest number of classes of workers. It should also be noted that many public-sector workers do not have the right to bargain over tech change; for instance, the *Ontario Crown Employees' Act*, covering about 30,000 provincial government workers, specifically excludes technological change from the list of "bargainable" issues. For a useful discussion on the exclusion issue, see McDermott, "An overview," pp. 3-4.

CHAPTER 9

1 Heather Menzies, *Women and the Chip* (Montreal: Institute for Research on Public Policy, 1981), p. 73.

2 This particular group is one of the most hard-hit by new technology in the office, and in different ways. One way is by the stress put on them, as speed and efficiency are now monitored electronically. The other way is the wholesale disappearance of the data-entry task over the short or medium term. As firms get more sophisticated computerized systems, data entry functions will become obsolete. Experience and efficient methods of meeting the acceptable "quota" (of keystrokes) will eventually be useless. Most cases of displacement necessitate the retraining of these persons in a different type of work, and relocation is not always welcome. Cashiers in retail stores may face the same problem when the use of debit cards becomes more common.

3 United Nations, *The Economic Role of Women in the ECE Region: Developments 1975/85* (New York: U.N., 1985), p. 11.

4 Cécile Dumas, "Occupational trends among women in Canada: 1976 to 1985" in Statistics Canada, *The Labour Force*, Cat. 71-001, October 1986, pp. 83-128.

5 Statistics Canada, *Women in the Work World*, Cat. 99-940 (Ottawa: Supply and Services Canada, 1984).

6 The public sector is defined as including education and health services; social services; religious organizations; household services; and public administration and other government offices.

7 See Gordon Betcherman and Kathryn McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986).

8 A union membership survey done by Statistics Canada in 1984 found that 4.3 per cent of total female employment in wholesale and retail trade was unionized. In the finance, insurance, and real estate industry, the corresponding figure was 5.4 per cent; and in services to business, 1.4 per cent of female workers were unionized. See Statistics Canada, *Survey of Union Membership*, 8412 Microdata Documentation (Ottawa: Statistics Canada, 1986). Also, see Menzies, Women and the Chip; and Labour Canada, *In the Chips: Opportunities, People, Partnerships*, Report of the Labour Canada Task Force on Microelectronics and Employment (Ottawa: Supply and Services Canada, 1982).

9 See David L. Birch and Susan J. MacCracken, *The Role Played by High Technology Firms in Job Creation*, MIT Program on Neighborhood and Regional Change (Cambridge, Mass.: MIT, 1984).

10 In 1984, 19 per cent of all part-time workers were unionized compared with 41 per cent of all full-time workers. The distribution by sex was as follows: 21 per cent of all female part-time workers; 36 per cent of female full-time workers; 14 per cent of male part-time workers; and 44 per cent of male full-time workers. The corresponding figures for private-pension-plan coverage in 1984 were 10 per cent of all part-time workers and 54 per cent of all full-time workers. The distribution by sex was: 12 per cent of all female part-time workers; 48 per cent of all female full-time workers; 7 per cent of all male part-time workers; and 58 per cent of all male full-time workers. See Labour Canada, *Women in the Labour Force*. 1985-86 edition (Ottawa: Supply and Services Canada, 1986).

11 See Dumas, "Occupational trends" in Statistics Canada, *The Labour Force*.

12 See Organisation for Economic Co-operation and Development, *The Integration of Women into the Economy* (Paris: OECD, 1985).

13 For a detailed discussion of technological change in the finance, insurance, and retail industries, see Ontario Task Force on Employment and New Technology, Appendix No. 13 (*Employment and New Technology in the Chartered Banks and Trust Industry*); Appendix No. 14 (*Employment and New Technology in the Insurance Industry*); and Appendix No. 17 (*Employment and New Technology in the Retail Trade Industry*) (Toronto: Government of Ontario, 1985).

14 A recent survey of Quebec firms found that 10 per cent of word-processing-equipment operators worked part-time, while only 3 per cent of typists using regular typewriters did so. See C. Benoît *et al.*, *L'incidence de la machine à traitement de textes sur l'emploi et le travail* (Québec: Ministère du Travail, et Ministère de la Main-d'oeuvre et de la Sécurité du revenu, juin 1984).

15 For the banking industry, see Labour Canada, *A Survey of Part-Time Employment in Federally Regulated Industries*, vol. 1 (Ottawa: December 1985).

16 Public Service Commission of Canada, *Women in the Federal Public Service of Canada: A Decade of Change* (Ottawa: Supply and Services Canada, 1985), pp. 9-10.

17 The size of the Public Service Commission of Canada decreased between 1976 and 1985, from 277,311 to 223,173 positions (see *Annual Reports*, 1980 and 1985). Sixty per cent of all female employment in the public service was in the administrative support category, which includes most traditional clerical positions such as secretaries, office equipment operators, data processing, clerical and regulatory, and communications. The total amount of jobs (permanent and term) in that category fluctuated around 56,000 between 1979 and 1985, with the share of term or contract work increasing from 11 to 13 per cent. While this may appear to be a very small

increase, these jobs are characterized by very high turnover rates. In fact, they are the first jobs to be eliminated when budget cutbacks are imposed and when new technologies are introduced, as observed in our case studies. Furthermore, the proportion of part-time female employment in this category increased from 1 per cent in 1979 to 4 per cent in 1985.

18 Treasury Board has required the Employment and Immigration Commission to reduce its staff to make up some of the cost involved in setting up this nationwide system. The cut amounted to 430 person-years – less than 2 per cent of the EIC staff across Canada. Quebec and Ontario regions were to cut 122 each and the balance was split between the other regions.

19 Marcy Cohen and Margaret White, *Taking Control of Our Future: Clerical Workers and New Technology* (Burnaby, B.C.: Women's Skill Development Society, 1987).

20 Interviews with various managers, directors, section heads, and one union representative, and a survey of employees' opinions on the changes, constituted our main methodological tools.

21 A case study of the introduction of word processing into 100 Montreal-based companies yielded results on job satisfaction very similar to ours. On equivalent measures, the "interesting nature of the work" was ranked high. On "possibility of promotion," a slightly higher proportion than ours did not feel that technology was a step-ladder to promotion. The "isolation" factor was not a concern, as the majority reported no change in their contacts with other employees. See R. Morisette and A. Desjardins, "Impact de la machine à traitement de textes sur les conditions de travail," *Le Marché du Travail* 7, no. 4 (April 1986):60-73.

22 Daniel Boothby, *Women Reentering the Labour Force and Training Programs: Evidence from Canada*, Economic Council of Canada (Ottawa: Supply and Services Canada, 1986), pp. 31-32.

23 Canadian Congress for Learning Opportunities for Women, *Decade of Promise: An Assessment of Canadian Women's Status in Education, Training and Employment: 1976-1985* (Toronto: Canadian Congress for Learning Opportunities for Women, 1986), pp. 118-120.

24 Secretary of State and Statistics Canada, *The Class of 82* (Ottawa: Supply and Services Canada, 1986).

CHAPTER 10

1 The remaining 9 per cent were classified as "degree of disability unknown." See Statistics Canada, *Health and Disability Survey*, October 1983/June 1984, Cat. 82-555.

2 David K. Foot and Jeanne C. Li, "Youth unemployment in Canada: A misplaced priority?," Policy Study 85-7, Policy and Economics Analysis Program, Institute for Policy Analysis, University of Toronto, July 1985.

3 R. Paul Shaw, "The burden of unemployment in Canada," *Canadian Public Policy* 11, No. 2 (June 1985):143-60.

4 See, for example, Fred Wien, *Rebuilding the Economic Base of Indian Communities: The Micmac in Nova Scotia* (Montreal: Institute for Research on Public Policy, 1986).

5 Although the combination of the impact of labour-productivity change and the impact of change in demand for intermediate inputs is the best measure of the impact of technological change available, it is still only an approximation. This measure captures not only changes in the technical relations of production generated by technological change, but also changes in relative factor prices. It also completely misses "scale effects." The latter is the increase in output (and employment) that follows from technological change, increased productivity, lower prices, and increased demand for firms' output.

6 Ken Dryden, *Report of the Ontario Youth Commissioner*, 1986.

7 Information on the Survey of Occupations was obtained from Frank Schmidt in the Department of Rehabilitation at the CNIB.

8 Office Automotation Show for the Disabled, Feb. 17-18, 1987, Ottawa Congress Centre. Offered by Office Automation Services and Information Systems (OASIS) Directorate of Supply and Services Canada.

List of Tables, Charts, and Figures

Tables

2-1	Indicators of Economic Performance, by Technological Sector, Canada, 1971-81	11
2-2	Cost-Efficiency Performance, Nonmanufacturing Industries, Canada, 1971-81	14
2-3	Cost-Efficiency Performance, Manufacturing Industries, Canada, 1971-81	14
2-4	Distribution of Employment Increases in Clerical and Related Occupations, by Industry, Canada, 1971-81	16
3-1	Change in Industry Employment, by Source, Canada, 1971-81	24
3-2	Percentage Change in Industry Employment, by Source, Canada, 1971-81	25
3-3	Change in Occupational Employment, by Source, Canada, 1971-81	29
3-4	Percentage Change in Occupational Employment, by Source, Canada, 1971-81	32
4-1	Projected Distribution of Employment and Employment Growth, by Technological Sector, Canada, 1987-96	40
4-2	Actual and Projected Employment Growth in Selected High-Tech Occupations, Canada, Selected Years, 1971-96	40
4-3	Distribution of Computer-Based Technological Change, Introduced and Planned, in the Manufacturing Sector, by Type of Technology, Canada, 1980-85 and 1986-90	41
4-4	Actual and Projected Sales of Computer-Aided Design (CAD) Equipment, Canada, 1982-90	42
4-5	Distribution of Employment in Innovating and Non-Innovating Establishments, by Occupational Group, Canada, 1980 and 1985	43
4-6	Actual and Projected Employment, by Industry, Canada, 1981 and 1995	44
4-7	Projected Labour Displacement and Re-Employment, by Industry, Canada, 1981-95	45
4-8	Actual and Projected Employment, by Summary Occupation, Canada, 1981 and 1995	47
4-9	Projected Labour Displacement and Re-Employment, by Summary Occupation, Canada, 1981-95	48
4-10	Actual and Projected Employment, by Detailed Occupations, Canada, 1981 and 1995	49
4-11	Projected Labour Displacement and Re-Employment, by Detailed Occupations, Canada, 1981-95	52
4-12	Education Content of Labour Affected by Technological Change, Canada, 1981-95	54
5-1	Individual Employment-Income Inequality Indicators within Techno-Occupational Groups, Canada, 1981	58

5-2	Distribution of Work Force and Employment Income, and Relative Mean Employment Income, by Sex, Age Group, and Education Level of ELFP Individuals, Canada, 1971, 1979, and 1983	62
5-3	Distribution of Work Force and Employment Income, and Relative Mean Employment Income, by Employment Status and by Occupational and Industrial Groups of ELFP Individuals, Canada, 1975, 1979, and 1983	63
5-4	Employment-Income Inequality Indicators by Sex, Age, and Education Level of ELFP Individuals, Canada, 1971, 1979, and 1983	64
5-5	Employment-Income Inequality Indicators by Employment Status and by Occupational and Industrial Groups of ELFP Individuals, Canada, 1975, 1979, and 1983	65
5-6	Changes in Absolute and Relative Employment and Average Hourly Earnings, by Industry, Canada, 1976-85	67
5-7	Changes in Occupational Composition of Industries, Canada, 1976-85	67
6-1	Working with Technology Survey: Sample Distribution, by Province and by Industry, Canada, 1985	71
6-2	Office Automation: Scale of Introduction, by Industry, Canada, 1980-85	72
6-3	Process Automation in the Manufacturing Sector: Scale of Introduction, Canada, 1980-85	73
6-4	Measures of Technological Intensity, by Region, Canada, 1980-85	74
6-5	Measures of Technological Intensity, by Industry, Canada, 1980-85	75
6-6	Measures of Technological Intensity, by Manufacturing Industry, Canada, 1980-85	76
6-7	Measures of Technological Intensity, by Establishment Size, Canada, 1980-85	76
6-8	Measures of Technological Intensity, by Control of Establishments, Canada, 1980-85	77
6-9	Robots per 10,000 Persons Employed in Manufacturing, Various Countries, as of January 1, 1984	78
6-10	Actual and Projected Computer-Affected Work Force, by Industry, Canada, 1985 and 1990	82
6-11	Duration of Retraining Programs Resulting from Technological Change, by Method of Training, Canada, 1980-85	84
6-12	Work Force Retrained Because of Technological Change, by Occupational Group, Canada, 1980-85	84
6-13	Average Duration of Retraining Programs Resulting from Technological Change, Selected Occupational Groups, Canada, 1980-85	85
6-14	Recruits Hired in Response to Technological Change, by Occupational Group, Canada, 1980-85	85
6-15	Personnel Adjustments to Technological Change, Canada, 1980-85	86
7-1	Distribution of Part-Time Employment, by Type, and Hourly Wage Rates, Selected Companies, Canada, 1984	99
7-2	Benefit Coverage of Full-Time and Part-Time Employees, Selected Companies, Canada, 1985	99

7-3	Pay Rates of Part-Timers Compared with Those of Full-Timers Having Equivalent Jobs and Seniority, Selected Companies, Canada, 1985	100
7-4	Proportion of Employers Who Felt that Part-Timers, by Type, Were at Least as Good as Full-Timers in Certain Respects, Selected Companies, Canada, 1985	100
7-5	Performance and Cost of CEIC Work-Sharing Program, Canada, 1982-86	102
7-6	Proportion of Major Collective Agreements Containing Provisions for Alternative Work-Time Arrangements, Canada, 1972-85	103
7-7	Simulation (CANDIDE) of Net Impact on Major Economic Indicators of a One-Hour Reduction in the Work Week, Canada, 1987-95	105
7-8	Simulation (MESIM) of a Projected 5-Per-Cent Reduction in the Work Week, Canada, 1995	106
8-1	Union Density Trends and Employment Growth, by Industry, Canada, 1962-84	109
8-2	Collective-Bargaining Coverage and Occupational Composition, by Technological Sector, Canada, 1980	110
8-3	Assessment by Steelworker Officials of Technology-Related Clauses in Collective Agreements, 1983	112
8-4	Frequency of Various Technological Change Provisions in Collective Agreements, Canada, 1985	114
8-5	Frequency of Technological Change Provisions in Collective Agreements, Canada, Selected Years, 1972-85	115
8-6	Frequency of Technological Change Clauses in Collective Agreements, Selected Industries, Canada, 1985	116
8-7	Industries with Highest and Lowest Simple Average Frequencies of Technological Change Clauses in Collective Agreements, Canada, 1985	117
8-8	Frequency of Technological Change Clauses in Collective Agreements, by Jurisdiction, Canada, 1985	118
8-9	Proportion of Firms with Formal Worker Participation in Various Aspects of Business Operations, Ontario, 1984-85	119
8-10	Management's Perception of the Appropriate Role of Workers in Making Decisions Regarding Technological Change in Manufacturing and Services, Ontario, 1985	121
9-1	Three Major Sources of Change in Female Occupational Employment, Canada, 1971-81	132
9-2	Average Female Employment Income, by Clerical Occupation and Technological Sector, Canada, 1980	136
10-1	Industrial Distribution of Age Groups and of Native People, Canada, 1981	147
10-2	Distribution of Age Groups and of Native People, by Technological Sector, Canada, 1981	147
10-3	Sources of Employment Change, by Age Group, Canada, 1971-81	148
10-4	Share of Age Groups, Native People and the Disabled in Occupational Groups, Canada, 1981	149
10-5	Distribution of Employment in the Fastest-Growing and Fastest-Declining Occupations, by Age Group, Canada, 1981	150
10-6	Distribution of Employment in Selected High-Tech Occupations, by Age Group, Canada, 1981	150

10-7 Distribution of Employment in Occupations Potentially at Risk from Selected Computer-Based Technologies, by Age Group, Canada, 1981 151
10-8 Distribution of Special Groups, by Highest Level of Schooling Completed, Canada, 1981 152
10-9 Sources of Employment Change in Three Educational Attainment Groups, Canada, 1971-81 152
A-1 Sources of Growth in Unit Production Costs, Selected Industries, Canada, 1971-81 171

Charts

1-1 Employment Patterns, by Industry Sector, Canada, Selected Years, 1911-85 5
2-1 Employment Record of High-Tech Industries, Canada, 1971-85 10
2-2 Impacts of Technological Change on Employment, by Occupation, Canada, 1981 18
3-1 Employment Change Among Major Occupational "Winners," by Structural (Technological) Source, Canada, 1971-81 35
3-2 Employment Change Among Major Occupational "Losers," by Structural (Technological) Source, Canada, 1971-81 36
4-1 Distribution of Actual and Projected Computer-Based Technological Change, Canada, 1980-85 and 1986-90 41
4-2 Actual and Projected Number of Installed Robots, Canada, 1983-90 42
5-1 Distribution of Middle-Class Employment of Full-Time/Full-Year Individuals, by Technological Sector, Canada, 1971 and 1981 59
5-2 Income and Education Shares of Fastest- and Slowest-Growing Occupations, Canada, 1971-81 59
5-3 Average Level of Earnings of Workers, Canada, 1971-85 60
5-4 Total Income Quintile Shares for Individuals, Canada, 1971-85 61
6-1 Office, Process, and Other Automation Technologies as a Proportion of Total Applications, Canada, 1980-85 72
6-2 An International Comparison of the Use of Microelectronics in Manufacturing Processes 79
6-3 Groups Actively Involved in Planning for Technological Change, Canada, 1980-85 80
6-4 Actual and Projected Proportion and Growth of Work Force Using Computer Technologies, Canada, 1985 and 1990 81
6-5 Projected Growth of Workers Using Selected Technologies, Canada, 1985-90 82
6-6 Strategies Used by Innovators for Meeting New Skill Requirements Resulting from Technological Change, Canada, 1980-85 83
6-7 Types of Programs Used for Retraining Necessitated by Technological Change, Canada, 1980-85 84
7-1 Distribution of Establishments with Organizational Innovations, by Type, Canada, 1985 93
7-2 Part-Time as a Proportion of Total Employment, Indicating Portion of Which Is Involuntary, Canada, 1975-86 96
7-3 Part-Time Employment, by Sector, Canada, 1975-86 97
7-4 White-Collar Share of Part-Time Employment, Canada, 1975-86 98

7-5	Average Weekly Standard Hours of Work, Canada, 1973-85	104
8-1	Occupational Structure of Innovating and Non-Innovating Establishments, Canada, 1985	111
9-1	Women's Share of Employment Growth, by Sector, Canada, 1971-81	130
9-2	Sources of Change in Employment of Women in Some Office-Related Occupations, Canada, 1971-81	134
9-3	Female/Male Ratio of Employment Income in High-Tech Industries, Canada, 1980	135
9-4	Total Female Employment, by Occupation, 1976 and 1985	137
9-5	Female Employment: Part-Time as a Proportion of Total, Canada, 1976, 1982, and 1985	137
9-6	Female Part-Time Employment: "Involuntary" as a Proportion of Total, Canada, 1976, 1982, and 1985	138
9-7	Female Part-Time Workers in Three Industrial Sectors, Canada, 1976, 1982, and 1985	138
9-8	Female Part-Time Employment in Three Industrial Sectors: "Involuntary" as a Proportion of Total, Canada, 1976, 1982, and 1985	139
9-9	Women as a Proportion of Full-Time University Enrolment, Selected Disciplines, Canada, 1976 and 1984	142
9-10	Managerial and Professional Employment, by Sex, Canada, 1976 and 1985	143
10-1	Change in Employment as a Result of Changes in Technology and Final Demand in Three Educational Attainment Groups, Canada, 1971-81	153

Figures

1-1	Selected Occupations that Have Emerged from New Technologies, Canada, 1980-85	4
1-2	Selected Occupations Potentially Affected by Computer-Based Technologies	6
1-3	Computer Technologies in Canada in the 1980s	7
3-1	Demand, Production Recipes, Industrial and Occupational Employment - The Linkages	22
6-1	Economic Council of Canada Case Studies	70
9-1	Case Studies of Women and Office Automation: Characteristics of Survey Respondents, 1986	141

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